THE NEW SCIENTIST

5 DECEMBER 1957

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FLIGHT INSTRUMENTATION IN INSECTS
by Dr. P. T. Haskell

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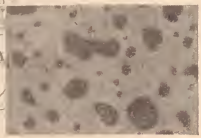
Animal physiology by Dr. R. F. Glascock

PRESIDENT EISENHOWER'S ILLNESS
report from America by John Lear

VOLUME 3 NUMBER 55 ONE SHILLING WEEKLY

pray be seated . . .

THE discovery of foam rubber by Dunlop was almost an accident. Experiments with a cake-whisk showed air could be introduced into liquid latex. The addition of certain chemicals and other ingredients preserved the millions of tiny "cells" produced by the bubbles of air . . . and Dunlopillo latex foam began its life as the comforter of man. There is no end to the versatility of this "aerated" rubber, from its use as a chair cushion or mattress in the home to providing seating for the benches in the House of Commons. So, from simple origins, latex foam has become yet another Dunlop "essential" in homes, hospitals, public buildings and transport, yet another example of far-seeing research and development.



The original cake-whisk used in the discovery of foam rubber. Right: a micro-photo showing a magnification of the tiny air-channels in a piece of "light-as-air" latex foam.

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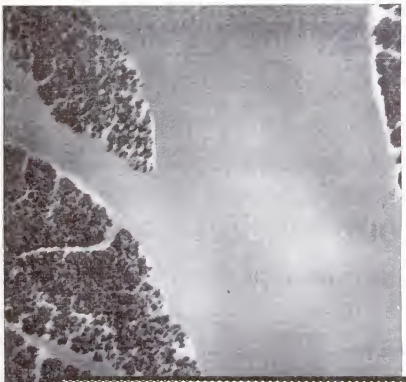
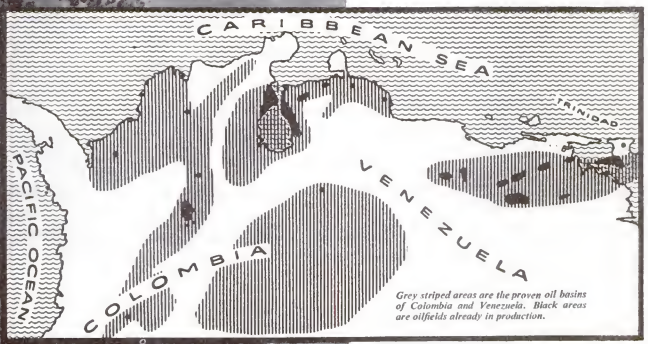


Oil for the future

Where the seas receded from the continents a million or a hundred million years ago, they left deposits that have since turned into oil.

Oil is a young industry, not yet out of its first century. And the next fifty years must see the world production of oil double, and perhaps treble: to supply the energy demands of a world population that is increasing at the rate of 30,000,000 a year.

Our most certain supplies of new oil lie in the proven oil basins. These stretch across the continents and contain the great river systems: the Mississippi, the Tigris/Euphrates, the Ural/Volga, the Ganges and the Indus.



Grey striped areas are the proven oil basins of Colombia and Venezuela. Black areas are oilfields already in production.

New oilfields are being discovered in the vast expanses of these basins, where the seas once covered the earth.

But the search for new oil sources is being extended under the deserts of the Sahara, the great rain-forests of South America, the Arctic Circle and the continental shelves of the high seas. The geologists and the geophysicists who locate the new oilfields are the explorers of today.

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FROM THE CITY OF STEEL. Broadsheet No. 2

The World is our Market

HOW BRITISH SHEET STEEL AND TINPLATE ARE FACING COMPETITION ABROAD

"BEFORE the war." That's a phrase we still see every day in the newspapers; and one we hear every day. Productivity, incomes, sporting achievements: all are judged by their equivalents *before the war*.

Yet "before the war" is now eighteen years ago. Next year it will be nineteen; the year after, twenty. "Before the war" is a fixed point in time, and we should forget about it.

What matters to us, to everybody in this country, is *after the war*. And the war has now been over for twelve years. What has been achieved by our industries during that time? How have they done in the most vital market of all—the export market?

In this Broadsheet, we tell you something about the difficulties that faced the sheet steel and tinplate industries after the war; what action was taken to overcome them; and how successful that action has been.

AFTER THE WAR

When the war ended, much of Britain's industrial plant was worn out or obsolete. There had been six years when little development or modernization of plant had been possible. And before Britain could begin to export in quantity, she had first to satisfy home demands.

The first big stage in the modernization of the sheet steel and tinplate industry came with the formation of The Steel Company of Wales in 1947. A vast new integrated steelworks was built at Margam, in Glamorgan, and a new tinplate works went up at Trostre, near Llanelly. These two works went a long way towards satisfying British demand for sheet steel and tinplate.

THE TURN OF THE TIDE

Britain's competitive position is now looking much happier. For example, in 1956 The Steel Company of Wales opened another huge tinplate works at Velindre, near Swansea. This, a sister plant to Trostre, has doubled the Company's capacity for the production of modern tinplate. At last we can satisfy the demands of the British manufacturers and still have tinplate available for export. All we have to do now is to sell it.

Countries who buy tinplate know very clearly what they want: tinplate of the right quality, at the right price, and by the right date. In the race to fulfil these requirements, The Steel Company of Wales is doing well.

In 1956, the value of our direct exports of sheet steel and tinplate was £18,000,000; this year we hope it will be £28,000,000, which means a lot to Britain in food or raw materials.

FURTHER DEVELOPMENT

The struggle goes on, all the same. Markets have to be held tenaciously; and new markets have to be won.

So planning for further development has already begun, and the result will be to increase the Company's output of steel by 25%.

Britain has always been renowned for quality; for the last few years quantity alone has restricted her challenge. When the developments of The Steel Company of Wales, and those of other companies in the industry, have been completed, this last handicap will have gone. The future for Britain is as promising as it has ever been. This is what should be remembered; not "before the war."

Some of the countries and territories to which the products of The Steel Company of Wales are now exported:

ADEN	GREECE	PORTUGAL
ARGENTINA	HONG KONG	PORTUGUESE EAST AFRICA
AUSTRALIA	INDIA	RHODESIA & NYASALAND
AUSTRIA	IRAN	SPAIN
BELGIUM	IRAQ	SUDAN
BRITISH EAST AFRICA	IRISH REPUBLIC	SWEDEN
BRITISH WEST AFRICA	ISRAEL	SWITZERLAND
BRITISH WEST INDIES	ITALY	SYRIA
BURMA	MALAYA	THAILAND
CANADA	NETHERLANDS	TURKEY
CEYLON	NEW ZEALAND	UNION OF SOUTH AFRICA
DENMARK	NORWAY	URUGUAY
FINLAND	PAKISTAN	U.S.S.R.
FRANCE	PARAGUAY	VENEZUELA
GIBRALTAR	PHILIPPINES	WESTERN GERMANY

THE STEEL COMPANY OF WALES LIMITED

research at Napier...

. . . is the job of lively and active teams of men and women under the direction of the Chief Research Engineer. At the moment these teams are working on a variety of mechanical engineering projects such as high performance gearing, stress and vibration measurement, rotating fluid seals, gas dynamics, fuel injection, bearings of all kinds (including high temperature types and those lubricated by gases and other unconventional lubricants). Associated with these projects there are the special problems of instrumentation and the final application to aero gas turbines, high performance diesel engines and turbochargers. In addition, the Napier Research Organisation is taking on an increasing weight of work for associated companies, so there are always vacancies for qualified and experienced research engineers. If you have the right training and experience and are attracted by the opportunities offered by Napier research, our Personnel & Training Officer would like to hear from you.

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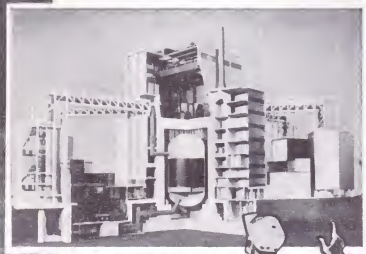
Welding begins inside the bowl of the reactor vessel. Six teams of John Thompson welders work outwards from the centre, welding the 3in. thick steel plates which have been assembled and are temporarily held in position by clamps. Further welding teams began working on the next ring of plates shortly after this photograph was taken. In the background, an X-ray unit stands ready inside the bowl for weld examination.

A welder works from the bottom centre of the reactor vessel, welding together the 3in. thick 'petal' plates which form the lower bowl. Accurate edge preparation of the plates has been achieved by a specially developed flame planing technique in John Thompson's works. The temperature of the weld area is maintained between welding runs by means of flame torches, one of which is seen ready to hand, in front of the welder.

Buttercups at Berkeley...

John Thompson's construction men — familiar in their yellow helmets on power station and industrial sites throughout Britain — are now at work on the Central Electricity Authority's first commercial nuclear power station being built by the A.E.I. — John Thompson Nuclear Energy Company at Berkeley, Gloucestershire. Crisply, the construction programme proceeds to a minutely planned schedule. The bottom dome portion of one of the huge 1,000 ton reactor vessels was transported in sections to the site where it is being welded together to grow simultaneously with the reactor building. The "Buttercups" are speedily getting on with this job in which they are building the reactor vessels, the thermal shielding, the sixteen large heat exchange towers, gas ducting and nuclear fuel loading machines.



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NOTES AND COMMENTS

Telephone techniques

TWO revolutions in telephone operating technique are at present being carried out by the General Post Office. The first, and to the average subscriber the more obvious, is the gradual replacement of manual by automatic operation. But at the same time another change of equal significance is being planned, and will begin to take effect in the next few years. This is the replacement of the electro-magnetic switching techniques currently in use by electronic techniques derived from computer practice.

A small step in this second revolution was taken last week when equipment employing a magnetic drum storage device which has been installed for field trials at the Lee Green automatic exchange in south-east London was officially inaugurated by the Engineer-in-Chief of the Post Office, Sir Lionel Harris. Known as the magnetic drum director, this equipment has been developed by the Automatic Telephone & Electric Co., Ltd.

The magnetic drum detector is a considerable improvement on the existing electro-mechanical equipment in use in London and other large cities throughout the world. In principle, however, its functions are exactly the same : it stores the dialled numbers, translates them into routeing directions, and ensures that calls are put through as quickly as possible.

The magnetic drum itself is a bronze cylinder about twelve inches in diameter and three inches wide, with an extremely thin coating of nickel which forms the medium for the magnetic records. These consist of sequences of magnetic "dots" which can be packed closely enough together to give 100 dots to the inch of circumference and about 10 tracks of dots to each inch of width. Numbers and instructions are recorded in the binary code used in computers: four dots are required to record a single digit, and the seven-digit number dialled by a caller thus needs 28 dots.

In operation the drum rotates at about 1,800 revolutions a minute. Some of its tracks are used for memorising records which in the normal course of events are permanent, such as the 700 or so translations most likely to be required, while others are used as control tracks either for synchronising the operation of the whole unit or to provide individual memories for the 114 switch control units.

The development of these electronic techniques for telephone operations is meeting with success right from the early stages. The first installation of equipment of this sort was made at Richmond in 1952, and it soon became clear that this early equipment was more reliable than its electro-magnetic equivalent, although the latter had been developed over many years. The first complete trial exchange is expected to be opened in 1960 at Highgate Woods, while the subscriber trunk-dialling system which will open in Bristol in 1959 will be fully electronic.

Computer techniques, in fact, are proving their worth in telephone work. They are likely to become still more widely used as automation spreads through industry.

The sentimentalists and the cheeseparers

MOST of us still take a shockingly sentimental view of Nature conservation. The Sorelian myth of the bird sanctuary still dogs the efforts of those who are trying to transform the conservation of our natural resources from an æsthetic ideal into the technological branch of land management and use.

There are three distinct aspects of the work of the Nature Conservancy, whose eighth annual report has just appeared in what must surely be the record time for a Departmental report, only 59 days after the end of the period to which it refers. There is first of all the misleading æsthetic aspect, of which nearly everybody still automatically thinks when the words "Nature conservation" are mentioned. The preservation of our heritage of wild life is, of course, just as important as the preservation of our heritages of art and architecture; but there is far more to Nature conservation than that.

As the Conservancy points out, it is now generally accepted that agriculture must be based on applied science, but even among the keenest supporters of Nature conservation it is still too little appreciated that land use and land management can and must be based on both basic and applied research in the biological and physical sciences. These are the other two, and for the future economic welfare of Britain, much more important aspects of the Conservancy's work.

There can never have been a peacetime period when so many far-reaching decisions on land use are being taken. Nuclear power stations, airfields and other defence works, new

NOTES AND COMMENTS *continued*

oil ports, opencast coal and ironstone workings, large-scale afforestation, and the conversion of rough grazings into productive hill pastures are all changing the face of Britain faster than ever before.

Every one of these schemes calls for informed scientific advice on the impact of the consequent changes on the surrounding natural and agricultural plant communities. To take one instance only, what could scientific land management do to prevent the rapid run-off of storm water in south-east Scotland that has three times in ten years seriously interrupted traffic on the main east coast railway route from London to Scotland?

On the results of the Nature Conservancy's research programmes, at present woefully starved of funds, depend a hundred and one decisions where a wise choice may cause our grandchildren to bless us—and a wrong one make them deride our shortsightedness. When the vast sums disposed of by research bodies connected with nuclear power and defence are considered, the £226,000 spent by this still wealthy country on acquiring the knowledge on which the future welfare of the land itself depends must be rated as cheeseparing indeed.

French steaks on the hoof for Britain?

IT is a favourite farming cliché that Britain is the stud farm of the world —and like many clichés it is not as true as it was in the nineteenth century, when we were unrivalled exporters of livestock.

In several respects—the adaptation of stock to hot climates and the development of hornless beef cattle—the Americans are now well ahead of us. In the last few years we have had to go to Sweden to find a consistently reliable bacon pig, to Australia and America for polled Herefords, to Holland for Friesians.

Now the beef world, the last stronghold of complacency, is in a tizzy because some of our agricultural scientists have suggested that there might be a superior beef breed in France which is worth bringing over here. The breed is the mighty Charollais of central France, which provide most of the steaks with which tourists in Paris are familiar.

They are a huge—by British standards—white breed, originally kept as draft oxen, which appears capable of making remarkably fast liveweight gains. They have been tried with success in America, and in their own country the steers, under commercial management, reach 10-11 cwt. at 15 months and 13 cwt. at two years. This is an appreciably faster rate of growth than most British breeds can manage unless they are fed on fatstock show rations.

The use of beef bulls to cross with those members of the dairy herd which are not required to breed pure for dairy replacements has become increasingly important here, and it has been suggested that the Charollais might well be worth trying out as a cross on our Ayrshire milking cows. For the bony little Ayrshires have not "nicked" very satisfactorily with any of the British beef breeds. Milk Board scientists have recently had a look at the Charollais in France, and Dr. John Hammond, our foremost livestock expert, has reported favourably on their potentialities.

These moves have been greeted with howls of anguish from the beef breed societies. It is suggested that any importation of Charollais would be a confession of our own inadequacies, and the bogy of foot and mouth disease has been raised. Because of the possible disease risk the issue now rests with the Minister of Agriculture. On the advice of his vets he will have to veto or approve any importation.

Royal Society honours the scientists

THE Royal Society celebrates its birthday each year by announcing the award of medals to some of its most eminent Fellows and other distinguished scientists. Last week, on the occasion of its 295th anniversary, the President, Sir Cyril Hinshelwood, gave the names of this year's medallists in the course of his anniversary address.

The senior medal, the Copley, awarded annually since 1731, is to be received by Sir Howard Florey, Professor of Pathology in the University of Oxford. He will be awarded in addition to the medal a sum of more than £1,000.

Florey is best known for his work on penicillin. He is still working on antibiotics, particularly such newly discovered ones as nisin and micrococcin, and is attempting to find drugs which will be more effective than current treatments for tuberculosis. He has made, among many other researches, a study of the course of this disease in the living animal using the transparent chamber technique to film the development of the tuberculosis foci.

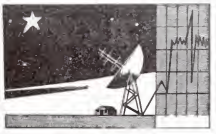
Each year the Council of the Society advises the Queen on the award of two Royal Medals, one for the physical sciences, one for the biological. The Copley medal can be awarded to a scientist from any country; it has been received by Bohr, Einstein, Mendeleef and Pavlov. But the Royal medals, which date from 1825, can go only to scientists whose work has been published in the Dominions. Professor W. V. D. Hodge, the Cambridge mathematician and creator of the theory of harmonic integrals, receives one of the Royal medals, and Professor F. G. Gregory, the plant physiologist, the other. Gregory was a pioneer in the study of plant growth in a controlled environment, and has experimented on the effects of low temperatures and different lengths of day on plant behaviour. He is probably best known for his work on the mechanism which brings about flowering and the reproductive phase in plants.

Dame Kathleen Lonsdale receives the Davy Medal for her work on crystal chemistry. It is given annually for the most important discovery in chemistry made in Europe or North America. The Medal has an interesting history. It came about through the bequest to the Royal Society by Dr. John Davy of the service of plate presented to Sir Humphry Davy for his invention of the miner's safety lamp. The plate was sold and used to endow the medal in 1877.

Other medallists are Sir Neil Hamilton Fairley, who receives the Buchanan Medal for his research on tropical medicine, and Professor J. Proudman, who is awarded the Hughes Medal for his outstanding work on dynamical oceanography and in particular on storm surges, such as that which caused the East coast floods in 1953.

NOTES AND COMMENTS *continued*

New Russian radio telescope



THE most interesting thing about the radio telescope which Dr. Semyon Kaikin has announced in Moscow is the short wavelength at which it operates. While the Jodrell Bank telescope works down to 21 cm. and the 45-foot telescope at Malvern down to about 10 cm., the Russian instrument is designed for 3 cm. At that wavelength, which calls for great precision in the design and construction, it is probably the most powerful radio telescope in the world.

But it is not, after all, so very large. It is apparently a trough-like reflector 420 feet long and about 10 feet wide, much smaller in collecting area than the trough-like aerials at the Mullard Observatory, Cambridge. Though the principle used is not yet clear, it is almost certainly an interferometer, which scans across an object in the sky as the Earth turns and records the signals from it as a wavy trace. The Soviet scientists may be following the technique used at Cambridge, in which the long trough aerial is accompanied by a small portable aerial which is moved along a line at right angles to the axis of the main reflector.

The charting of 3 cm. emissions from the radio sky will be an important contribution to science, and almost certainly has nothing to do with the Sputniks. The Russian radio physicists and astronomers are known to be particularly interested in using 3 cm. waves to map the variations in temperature across the Sun's surface, particularly in the neighbourhood of sunspots, and the new telescope may well give them the precision they need to do the job accurately—though in this case the moving aerial technique would be at a disadvantage because conditions on the Sun are always changing.

The chief problem in making a large telescope work at 3 cm. is transporting the signals to the recorder without undue loss, and the Soviet scientists have apparently achieved this over a distance of 210 feet. The quality of the equipment must be high.

Pruning the defence research budget

AN ominous reminder appeared last week that the promised review of defence research establishments hinted at earlier in the year by the defence White Paper is now an established fact. The Admiralty referred directly to it in answering suggestions made by the Select Committee on Estimates about amalgamating some naval establishments. These certainly seem to have been the first to feel the axe.

At the end of September a programme for concentrating naval research into two groups, above-water and under-water weapons, was announced. It was said at the time that "savings will be partly achieved by an overall reduction in staff numbers." At the end of this week an announcement was expected on the future of the Air Ministry's half-built rocket range in the Hebrides.

The switch in defence policy from aircraft to missiles makes a review of research establishments necessary on purely practical grounds. What, for example, is the future of a big establishment such as Boscombe Down, used for service trials of military aircraft? How much of the new wind tunnel facilities at Bedford have been outstripped by events and what proportion of them are suitable for missile research? What is the future of the Royal Aircraft Establishment at Farnborough?

But over and above this, the review is designed to save money. The Government is aiming to cut its research expenditure by as much as one-quarter, which would mean a reduction from £200 millions a year to only £150 millions.

Defence research can no longer be done in an improvised laboratory on a shoe-string budget; its cost is skyrocketing as projects become more complex. To cut expenditure at this time, therefore, means cutting the amount of work done by a proportionately greater amount.

No one to bring up the rear

TEST pilots in Britain work under several handicaps, most of which have to do with the small size of the country and its generally overcast skies. But a complaint made by the chief test pilot of English Electric, R. P. Beamont, in a paper to the Royal Aeronautical Society throws a new light on the perennial question of why it takes so long to develop fighter aircraft in Britain.

He referred to the official attitude towards "chase" aircraft. These are machines chosen generally, but not necessarily, from the fastest service aircraft available to fly behind or alongside the test pilot and tell him how his aircraft is behaving. Whatever instruments in the cockpit may say, only a "chase" pilot can tell for certain whether the aircraft is on fire and if so, what are its chances of landing. The test pilot, with his limited field of vision, can rarely see the tell-tale evidence for himself.

For the same reason an experienced pilot watching from another aircraft can often see more of what is happening to the machine under test and can pass this information on to its pilot.

In the United States, squadron strength units of experienced pilots are maintained specially for this purpose. Mr. Beamont's complaint, and it is a serious one, is that it is all too difficult to get the same facilities in this country. A pilot has usually to run into trouble before he can make a case for a chase aircraft to accompany him on the next flight. "This," said Mr. Beamont with commendable restraint, "is wasteful and also fails to cover the most important aspect of 'chase' flying, namely that of providing the test pilot with immediate confirmatory advice when things go wrong in the first instance."

In most cases the chase aircraft and its pilot come from the Ministry of Supply; its arrival depends on being able to find a serviceable aircraft with the right cameras that is not already engaged on some other work. It may be days before this can be done. There is a strong case for allocating some aircraft permanently to chase flying duties, or at least for reconsidering the present haphazard arrangement.

How Britain can get more scientists

Make university standards more flexible. Raise teaching salaries. "Sell" the importance of education to parents. Bring more women into scientific and technological work. These and other suggestions are advanced below

by Professor C. F. CARTER

IT is agreed, *nem. con.*, that we need more scientists and technologists, but there is no agreement about how to achieve this desirable result—indeed, there is a notable lack of good ideas on the subject. At a conference organised by the British Association at Leeds last July, I put forward some tentative and inadequate ideas of my own to stimulate discussion. This article flies much the same kites, for I believe that we shall not find effective policies without more discussion and controversy. I should like to emphasise that the kite-flying is strictly personal, and must not be taken as committing the Science and Industry Committee [appointed by the Royal Society of Arts, the British Association, and the Nuffield Foundation], which may in due course wish to issue a report on the matter.

Our preoccupation with the successes of our great industrial rivals causes a certain lack of balance in British attitudes. We have in fact moved far and fast in increasing the supply of scientists and technologists. Even over the last two or three years, a considerable change has taken place in the choice of subjects by boys at school. An exceptionally large generation of youngsters is passing through the schools, and will shortly be beginning working life. The cause for disquiet is not the record of the recent past, nor the prospects for the immediate future. It is the fear that our educational system, though it may successfully increase supply by another 30 per cent., is quite unsuited to the task of doubling or trebling the flow of highly trained people.

There is, of course, no known prospect of doubling or trebling the supply of people of quite exceptional ability. I would judge that the British educational system provides for such people reasonably well. It is the proper use and training of more ordinary ability on which we must concentrate attention. On this our failure is, I think, best described as sociological rather than educational; it is a failure to use our understanding of the society in which we live to support the purposes which are important to that society's survival.

Thus, it is certain that grammar schools have more prestige than secondary modern schools, and that universities have more prestige than technical colleges. I would judge it of little use to talk about "parity of esteem"; where alternative provision exists, it is almost certain that human nature will have a tiresome preference for one side. Can we use this preference to encourage more young people to prepare for scientific or technological careers? Many such careers require some substantial "academic" education, for instance in mathematics; but there is no clear line of division between "academic" and "non-academic" teaching, and therefore no necessity to confine the name and prestige of the grammar school to a narrow minority of the school places. The right attitude, I think, is to consider how far we dare to go in expanding grammar school provision; in contrast, some local authorities seem to start from an inflexible concept of an "academic" education for a small minority.

I do not believe that the universities best serve science or culture by maintaining inviolate the arbitrary standards of university education which have grown up in this country. We should rather be considering how many people we can bring within reach of some part of the advantages which a university has to offer. We should provide more elementary preparatory classes, both to help those who have not been well schooled, and to give a better chance to those who have made a wrong choice of specialisation at school. Such elementary preparation is indeed essential if we are to give the schools a chance to provide a general education, with an adequate content of science and arts subjects for every pupil at every age. New institutions for full-time higher education should, where possible, be organised on university rather than on technical college lines; and there might well be a multiplication of diploma and certificate work within the universities, providing especially for those incapable of staying a full degree course.

Of course, there are dangers in such a policy; it will

tend to create a new kind of undergraduate instruction, closer to the methods of the school-teacher, and it will tend to transfer to the graduate schools much of the respect now accorded to undergraduate course. But if one needs a great increase in the supply of highly trained people —taking in, almost inevitably, people below the present standards of university entrance—then it seems to me far easier to achieve this by offering university education at a lower level than by creating new institutions which would not carry the same attraction.

★

An increase in the output of highly-trained people implies a growth in the size and importance of the teaching profession, and if possible in the effectiveness of educational methods. I confess myself baffled at the problem of differentiating between teachers of different subjects in a way which will be, and will be seen to be, just; the laws of supply and demand are not a safe guide to what is possible in a labour market. I think, therefore, that we should face the necessity for a further general increase in teaching salaries, and in particular in the *final* salaries attainable, which are at present most unattractive relative to the prizes offered by other professions. I suspect also that there is need for more research into methods of teaching advanced mathematical and scientific subjects at school, and more examination of the possibilities of sharing facilities between neighbouring schools.

Other limits to the supply of scientists and technologists exist because we choose to ignore some very simple facts. One of these is that, in a school system involving much specialisation, the effective career decisions are made at the time of the choice of special subjects—which in some grammar schools is as early as the age of 13 or 14. It is little use limiting advice on careers to the last year of school life. I believe that in time specialisation could be greatly reduced, and could begin at a later age, but that for the present it is important that employment advisory services should operate before the crucial age of decision.

Another fact to which we give too little attention is that poor attainment at school, and early leaving, are related to an unfavourable home background. Something could perhaps be achieved by paying larger allowances for those remaining at school beyond 16; but the whole attitude of a home to education (and its need for quiet study) is not easily changed. If one were selling detergents or patent medicines, of course, one would not regard attitudes as wholly inflexible—it is the task of the advertiser and salesman to mould opinion to suit their commercial ends. I do not regard it as impossible to "sell" education effectively and with appropriate dignity; to emphasise, day in and day out, the value of the trained man and the need to use talent to the full; to increase the ceremonial and public recognition of those who have persevered to a successful end of a course. At the very least, I think we should try to find out why it is that the Welsh and the Scots accord to education an honour which the English deny. The "wastage" of clever children from working-class homes is far too great to be tolerated, and, if it provides a puzzling problem in sociology, that is all the more reason for research into its true nature.

Another problem, partly social, partly educational, and partly economic, is the small use made of women in scientific and technological work. In some professions, such as engineering, there are so few women that only the bravest will dare to enter; in others, masculine prejudice still plays a part. But employers have a justifiable doubt about the economic value of highly trained young women whose beauty of countenance suggests the likelihood of an early retirement to maternity. Re-employment when the family has grown up is notoriously difficult; there is need for special training facilities for matrons seeking to re-enter paid employment.

But, apart from these difficulties, we must also recognise the narrowness and inadequacy of the teaching of science and mathematics in many girls' schools—the science teaching often being concentrated on biology or on the elementary "general science." It is surely likely that, if better teaching existed (undertaken, where necessary, jointly with neighbouring boys' schools), there would be more highly trained young women able to offer skills in great demand, and to overcome the social and economic difficulties mentioned above.

It would be unfortunate if we became so pre-occupied with the question of increasing the number of scientists that we forgot the importance of using effectively those already trained. I have the impression that very little is known about the methods of working which will minimise the frustration of scientists and technologists, and make the best use of scarce ability. It is not enough, for instance, to relieve your most brilliant men of all routine work; they cannot think great thoughts all day, and periods of routine work may be necessary to avoid fatigue. Few firms have given systematic thought to the "science of using scientists," and more experiment and research is needed.

★

To those more expert in problems of education than I am, the suggestions I have put forward for discussion may seem stale and unprofitable. Yet what I miss in much of the discussion of such matters is a sense of the size of the problem. To seek to double the output of highly trained men is a reasonable aim, and is probably, indeed, too modest. Such a change cannot be brought about by marginal changes in existing institutions and practices. It is by their appropriateness to the achievement of an educational revolution that proposals for increasing the supply of scientists should be judged.

FLIGHT INSTRUMENTATION IN INSECTS

Some of the mechanisms on which they rely are analogous with aircraft instruments. In certain cases their ability to navigate also depends on methods resembling those which human pilots use

by Dr. P. T. HASKELL

ONE of the most famous questions ever put to the BBC Brains Trust was "How does a fly land on the ceiling?" Whatever the answer—whether the insect does a half-loop or a roll—it is clear that an aeronautic manoeuvre of some complexity is involved, and to carry it out successfully the fly must be getting information about its flight performance and its orientation in space. Any flying insect, in fact, faces this problem; it must have information relating to its movement, which can occur in six directions, backwards and forwards, up and down, left and right; it must be able to control any turning motion about its three axes, longitudinal, vertical and transverse; and it must be able to detect changes in motion during flight.

The instrumentation of a modern aircraft supplies this type of information to the pilot and can be classified roughly into two classes; first, instruments which supply information on flight motion, such as air-speed indicator, rate of climb indicator and turn and bank indicator, and secondly, those which indicate position or orientation, such as compass, altimeter and artificial horizon. In an aircraft, the pilot (or artificial pilot) acts as the co-ordinating centre for the information received from all this apparatus and controls both the aerodynamic response of the aircraft and also the engine. In flying insects both the flight motor and flight control consist of and depend on a set of muscles in the thorax—the so-called flight-muscles.

Certain of these muscles provide the main motive power for flight by causing the flapping motion of the wings; other muscles, which might be called control muscles, come into play when the insect wishes to manoeuvre by changing the angle of attack of the wing, or the form and amplitude of the wing-beat.

The operation of these muscles is controlled by impulses from the central nervous system of the insect which in turn are related to the input from a variety of sensory mechanisms; some of these mechanisms are unique to insects, while others are in principle analogous to certain aircraft instruments.

Let us first consider take-off; this is not the place to discuss the stimuli which lead to take-off, but the process appears in most insects to be a jump into the air. The first requisite after this is to get the "engine" going; in most insects there are sense organs in the tarsi or feet which record contact with the ground. When this contact is lost, beating of the wings commences at once. This can be demonstrated by attaching a cotton thread to a house-fly and suspending it in the air; if the fly is allowed to have one of its legs in contact with some object, such as a ball of cotton wool, it does not attempt to fly. If the object is removed, however, the fly at once commences to beat its wings and will only stop when it can touch the object again.

This "engine control" mechanism is more complicated in other insects; in the desert locust, for example, not only must its feet be out of contact with the

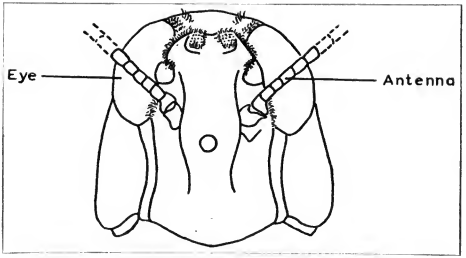


FIGURE 1. Diagrammatic view of the head of the Desert Locust, Schistocerca gregaria, *showing hair patches which are "aerodynamic sense organs" (After Weis-Fogh).*

ground but a special "aerodynamic sense organ" on its head must be stimulated. This organ (Figure 1) consists of patches of hairs distributed over the head which are sensitive to wind. If a locust is picked up from the ground, it will not usually begin to beat its wings until one blows upon these hair organs. These sense organs also enable the locust while still on the ground to face into the wind and make its take-off jump in this direction, thus ensuring the best aerodynamic conditions for initiating flight. These aerodynamic sense organs, which are found in locusts and certain moths, also act together with the tarsal organs during landing to stop the wings beating.

When the insect is launched into the air it is desirable for it to be able to gauge its air-speed; amongst other things such information enables the amount of effort needed from the flight motor to be regulated. Obviously, an insect in a head wind needs to expend more energy to maintain a constant flying speed than one in still air. It is now clear that flies at least have such an indicator—and probably other flying insects as well. It is a complex receptor called Johnston's organ, situated at the base of the antennae (Figure 2a). It is an organ which responds to the mechanical vibration or displacement of the "feeler" part of the antennae (Figure 2b). In flight, this portion of the antennae is held out in front of the fly and is acted on by the air flow sweeping over the head of the insect; it appears that the electrical discharges in the nerve from this sense organ are related to the speed of the air-flow and hence to the air-speed of the insect. Experiments in wind-tunnels show that the fly acts upon information received from this organ by altering the movement pattern of the wings.

Such a mechanism is remarkable enough, but the fly possesses another of even more complexity, which is nothing more or less than a gyroscopic turn indicator. Many people know that flies, that is, true flies in the sense of the entomologist, which comprises insects as diverse as house flies, mosquitoes and "Daddy-long-legs," have only one pair of wings. Once they had two pairs, but the hind set has been reduced in the course of evolution to curious knob-like protuberances called halteres situated just behind the wings (Figure 3a). For many years the function of these organs was a mystery, but it is now known that they function as gyroscopic organs in a system which controls the stability of the insect about its vertical axis. The mechanism acts in an analogous way to the gyroscopic turn indicator of a modern aeroplane; the principle used is that of gyroscopic precession, utilising the force generated when there is an angular displacement of the plane of rotation of the gyroscope.

The halteres are club shaped (Figure 3b) with a relatively heavy "head" end; they are articulated on to the thorax

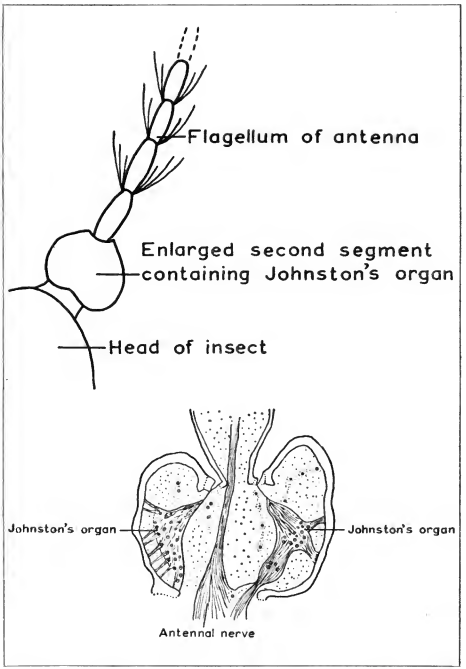


FIGURE 2. Semi-diagrammatic drawings showing (A, above) position and (B, below) structure of Johnston's organ at the base of the antenna of a mosquito. The sense cells can be seen attached at the point where the flagellum of the antenna is hinged on to the second segment.

FLIGHT INSTRUMENTATION IN INSECTS *continued*

of the fly with an elastic ligament and have a single muscle attached to them. When the muscle contracts, the haltere rises vertically and returns to its resting point under the restoring force of its elastic hinge.

Stroboscopic investigations of the halteres of a fly during flight show that they oscillate rapidly in a near vertical plane at about the same frequency as the wing beat but out of phase with it; this motion constitutes the gyroscopic oscillation. At the base of the halteres is an elaborate array of sense organs of various types; some of these monitor and control the reflex mechanism governing the oscillations themselves, while others record the gyroscopic forces set up in the haltere when the insect turns about its vertical axis. The fact that the system operates on the turning equilibrium of the fly can be demonstrated by cutting the halteres off an insect; flying movements are not interfered with, but a haltereless fly is characterised by a tendency to go into a spin—that is by instability about the vertical axis.

Flying insects thus have an array of mechanisms which control and stabilise their flight; what of their ability to navigate in space? Clearly in this field insects may make use of systems which can have no counterpart in aircraft; for example, many insects, particularly moths, navigate by chemical senses. However, brief mention may be made of two methods which are analogous with certain aircraft systems.

One is the "Sun compass reaction" of bees. In this system worker bees use the azimuth of the Sun as a fixed reference point, and they relate information about the direction of food sites to this fixed point. Since the Sun is in motion, the bees also have some clock compensating system to offset this, exactly as in the aircraft Sun compass. Furthermore, it can be shown that in cloudy weather, when direct sight of the Sun is impossible, the bees can estimate the position of the Sun by reference to the pattern of polarised light in the sky—a facility not available in aircraft compasses!

Lastly, mention may be made of a possible insect flight radar system; it has recently been discovered that in certain night-flying moths, at one point in the wing beat cycle a short pulse of very high frequency sound is emitted, frequencies up to 20 kc/s being present. The tympanal or hearing organs of these moths are particularly suited to detect very short pulses of high frequency sound, and it has been shown that one moth can detect another flying near it; it has also been suggested, although at the moment this is only speculation, that for a night-flying insect such a mechanism may operate as an echo-location system for avoiding obstacles.

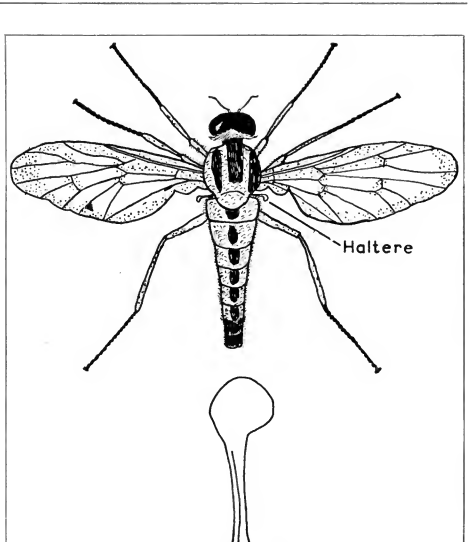


FIGURE 3. (*A—above*) *Drawing of a fly,* Leptis scolopacea, *to show relative size and position of the halteres.* (*B—below*) *Ventral view of left haltere of a dipterous fly* (*After Pringle*).

This short survey of some insect sensory mechanisms relating to the problems of flight may serve to emphasise the complexity of the problem and the neatness of many biological solutions; it seems possible that an application of some of these solutions to engineering problems would at least be suggestive in terms of future research.

The Chinese are "liquidating" their disease problems

The author is one of a group of British scientists recently returned from a visit to China. He describes the immense and carefully organised efforts being made to promote hygiene in cities and rural areas and to control transmission of epidemics

by Professor BRIAN MAEGRAITH

At present, with roughly a quarter of the world's total population within her frontiers, China is independent so far as food is concerned, and this happy state of affairs is likely to continue for some time, since it is estimated that, with improvement in farming methods and in the health and working capacity of the farmers, agricultural production can become adequate to feed the astonishing number of 800 million souls. To achieve this, the farming communities will have to be kept healthy and capable of producing the maximum yield from the fertile soil, and this in turn will necessitate the control of certain diseases which are still taking disastrous toll of life, health and efficiency of the people.

When these diseases are conquered, there will follow an inevitable rise in the gigantic population, already increasing at between 12 and 15 million a year. To maintain her vital nutritional independence, therefore, China will clearly have to limit the ultimate size of her population. Thus, at some stage she will have to strike a balance between her agricultural and human productivity. How this is to be done is one of the greatest human problems in the modern world.

In the meantime the Chinese are concentrating on the immediate problems of disease control. Big problems need big solutions, and they are determined, in totalitarian language, to " liquidate " their major community-wide diseases and to do so within a time limit, at present set at twelve years from now, that is, by the end of the third five-year plan. How they are going about this stupendous task is briefly described below.

In some of the more densely populated areas considerable success has already been achieved in the control of gastro-intestinal diseases such as typhoid and bacillary and amoebic dysentery, together with many of the common worm infections. This has necessitated a gigantic clean-up of the affected areas, a task which at the beginning must have looked almost hopeless.

The standard of hygiene reached already is, however, most impressive. In the large cities and towns, for instance, there is a notable absence of flies and an even more striking absence of litter. The streets are clean and free from the cigarette butts, papers, cartons, and other debris, which clutter up so many European cities. The successful control of flies, the litterless streets, and fanatical household cleanliness are having a profound effect on the spread of gastro-intestinal infections, especially in children, in whom, we were told, bacillary dysentery is much less common than it was.

How has this been done? How, for instance, can a notoriously dirty city be tidied up? The answer lies in the will of the people, who must be persuaded that it is worth while making their dwelling places clean and keeping them that way. The public co-operation demanded in such an exercise is immense, and the Government has been remarkably successful in achieving it. This may have been easier in a totalitarian State than elsewhere, and there was probably some element of compulsion needed to persuade the population to clear away hundreds of thousands of tons of dirt and litter from the streets and to swat flies and trench maggots until the insect population was brought under control. Nevertheless, the Chinese man in the street is essentially practical, and no amount of cajoling without a good leavening of common sense and social persuasion could have given him his present passionate belief in hygiene.

This vacuum-cleaning, so to speak, of the towns has helped considerably in controlling filth diseases, but still more is needed. Night soil must be conserved, and sewage and drainage schemes have still to be introduced in many places. However, in vast rural districts where other diseases such as schistosomiasis are being controlled, interim measures leading to conservation of night soil are already in operation and are helping considerably to limit further the spread of intestinal diseases. Perhaps this is nowhere more important than in communities like those living huddled together in sampans along the banks of the Pearl

TACKLING CHINA'S DISEASE PROBLEMS *continued*

River, for even the casual stranger to Canton must be impressed with the early morning parade of decorated family pots awaiting collection of night soil, which, not so long ago, would have been cast freely into the swirling yellow waters.

The growing regard for hygiene is reflected in the preparation of food. I was told, for instance, that "food poisoning" is uncommon, and this was certainly my own experience. In a life-time of travelling in the tropics I have, regretfully, come to regard "gyppy tummy" and similar mild gastro-intestinal disturbances as usual. In China I escaped them altogether. This may have been due to cleanliness, but I suspect it was also derived from the fact that Chinese food is always most thoroughly cooked, sometimes indeed more than once. The latter is probably the explanation of the comparative rarity of human tapeworm (*T. solium*) and *Trichinella* infections in China, despite their prevalence in pigs and the enormous consumption of pork.

The increasing control of gastro-intestinal infections is a great step towards a healthy community, but it is not nearly enough, for the Chinese are plagued with other endemic diseases which are still causing havoc, particularly among the very farmers upon whom the future prosperity of the country depends. Of these diseases the most important are malaria and schistosomiasis. A third disease, kala azar, which once ravaged great agricultural districts, has already been controlled by the combination of residual insecticides, mass treatment of cases and the elimination of dogs, which were regarded in some instances as reservoirs of infection.

Schistosomiasis in China is caused by infection with the fluke *Schistosoma japonicum*. It is endemic in twelve of the major food-producing provinces irrigated by the waters of the Yangtse and the rivers to the South. A recent survey disclosed that something over 11 million of the inhabitants of this great granary are suffering from the crippling physical and economic effects of the disease. Transmission of the infection depends on contamination of water with human faeces containing the eggs of the worm. Active larvae hatch from the eggs and invade certain snails, and from these other larvae are eventually discharged, which in turn infect the farmer by penetrating his skin when he is exposed to the water of the canals, creeks and irrigation ditches in which he spends his working life. The chain of transmission could be broken by preventing contamination of water by faeces (either by ridding the excreta of infective eggs or by proper conservation), by destroying the larval forms or by killing the host snails. In theory, control sounds easy. In practice it is extremely difficult and requires exceptional organisation and the all-out co-operation of the people exposed to risk. The Chinese have achieved both.

By the autumn of 1955 sufficient information had been collected concerning the incidence and morbidity of schistosomiasis to permit the formation of a national plan for the control of the disease. A lay committee was formed directly under the Communist Party to co-ordinate the attack, and each province was provided with its own central organisation below which subsidiary units for the districts, towns and villages are now being formed. All methods of control, from treatment of infected persons to destruction of snails, are carried out by these units, in which approximately 70,000 workers are already engaged.

Chinese children learning to serve food hygienically. Food poisoning is now uncommon.

To ensure the co-operation of the mass of the people concerned, intensive propaganda is being directed at the farmers with the intention of making them appreciate the economic and social dangers of the disease, its mode of transmission and the possible means of control. Village news-sheets, posters, cinemas, radio talks, group meetings and discussions are all being used to this end. Since the disease is the vital concern of the whole community, it has been decided that the community should help as much as possible in its control, and this principle is being brought into effect everywhere. For instance, the practical business of killing snails is not executed, as it is in other countries, by experts from outside, but by teams selected from the local farmers, who, after training in local antischistosomal units, take over the work in their own villages and paddy fields.

I saw this scheme working in the outskirts of Shanghai. The banks of the canals and streams in the villages were being slowly scorched by flame throwers. Beyond the village, the irrigation ditches and paddy fields were being cleared by arsenical spraying These simple procedures were estimated to kill about 80 per cent. of the snails during the summer.

In the winter the surviving snails burrow into the mud near the water line. Ditching this mud and packing it in the fields above kills most of them in a few months. It is believed that the combination of burning or poisoning plus ditching will soon reduce the snail population to the point where it ceases to be significant for transmission.

One further method of control which goes on all the time, illustrates the degree of general co-operation obtained. Until artificial fertilizers can be developed on a big enough scale, human excreta remains the cheapest and most valuable manure. Fortunately, the dangerous schistosome eggs do not live long if left in faeces without contact with water. Storage thus renders the material non-infective. Thanks to skilful propaganda this essential conservation of night soil is becoming an economic and social fact. Each family now has its own privy, a portable gaily-coloured pot. Every morning the contents are poured into large communal earthenware containers, which are sealed when full and left for the appropriate time necessary for the ammonia generated to kill the eggs, after which the faeces is safe for use in the fields. The collection of family night soil is assured by paying the family for it *pro rata*, so many cents a day per person, according to age. This scheme is also being used for the control of water pollution by fishermen, for each boat now has its own collecting pot, which is regarded as a regular source of income.

It is too early yet to talk about the results of these manœuvres in terms of reduced incidence of schistosomiasis. For some time there may be little obvious change, since in certain areas over fifty per cent. of the children and most of the adults are already infected. Nevertheless, there is every reason to believe that the disease will be brought rapidly under control.

Malaria occurs over most of China except in the extreme north and in the highlands of the north-west. The magnitude of the social problems it presents can be judged by the population at risk, which is estimated at somewhere between 300 and 350 million. The scientific difficulties of controlling the disease are inherent in these huge numbers and in the variety of geographical and epidemiological problems which have to be faced. Every kind of population, every kind of terrain (short of great heights) is involved. It is not surprising, therefore, that the distribution and epidemiology of malaria in China have not yet been fully defined. In a country the size of China the collection of information of this sort is a formidable task, and it says a great deal for the courage and resource of the modern Chinese that enough information has now been collected to permit large-scale planning. Although in many areas anti-malarial operations are already under way, the detailed national plan for control was finally settled only last year. The disease is to be controlled over the whole country. The ultimate aim is eradication, which is taken to mean what it says in some regions, and in others, a reduction of transmission by mosquito control and drug treatment to the point at which it becomes and remains insignificant. This is to be achieved by 1969.

The general campaign is similar in many respects to that already in operation against schistosomiasis. In rural areas, the active work is being done by teams drawn from the villagers or local farmers, organised through anti-epidemic stations devoted to training and treatment. At the provincial level these stations are guided by expert committees, acting in co-ordination with agricultural, forestry and allied organisations. Above these is the central committee, advised and assisted by the main scientific body which is being established in Shanghai. The whole scheme is finally the responsibility of the Ministry of Health.

Most of the preliminary work and planning has been done by the Chinese themselves, but on many points information and help has been required from outside. Owing to the unfortunate fact that China is at the moment not working within the World Health Organisation, such outside technical advice has had to come almost exclusively from Russia. The final operation nevertheless is to be essentially similar to others already in operation elsewhere on a smaller scale.

It has been decided to concentrate antimalarial measures for the present in the provinces of the south west, as far as the frontiers of Burma, Laos, and Viet-Nam. Outbreaks in this area are already being controlled by a combination of entomological and chemotherapeutic methods, the various techniques used being adjusted to suit local circumstances.

Mass treatment is being employed in some country districts as an adjuvant to mosquito control. Overt cases are treated and suppressive doses continued throughout the period of transmission. The drug in the widest use is the British synthetic Proguanil (Paludrine) which is the only antimalarial being produced on a large scale in the country. Reports indicate that it is so far highly successful and that resistant strains of parasites, which have been identified in other parts of the world, have not appeared. Other modern synthetic drugs, including chloroquine, are coming slowly into use, but have not yet been synthesised and have still to be imported from East Germany or Russia.

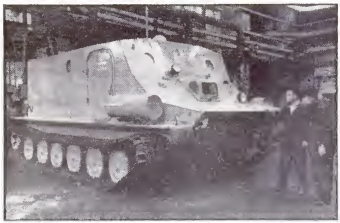
The progress of the attack on malaria has so far been slow, largely because the essential basic biological data has taken so long to collect, but enough of this information is now available to allow the major attack on the disease to develop. It is being pushed forward with energy and devotion and should have every chance of success.

SCIENCE IN INDUSTRY

New Russian tractors for Antarctic

SUPERCHARGED tractors with abnormally wide tracks are on their way from Russia to Antarctica to wipe out this year's terrestrial failure. By the end of July the Russians were to have established an I G Y station at the "pole of inaccessibility." They were beaten by shortage of power at the high altitudes at which they had to work and by deep, powdery snow. Next year they think their new tractors, like their Sputniks, will go well in the heights.

Their journey lies over a 10,000-ft. plateau where, on



New Russian snow tractor ready for shipment to the Antarctic.

their first attempt, the Russian team reported powdery snow 300 ft. deep in places. This area of frozen, shifting sands, together with reduced power in the engines, defeated the original tractors. The improved version, known as the Penguin, has wider tracks. Its superchargers should give it twice as much power at height as was available last time. Twelve Penguins are now on their way to the Antarctic. There is reported to be a heavier and more powerful type of snow tractor as well.

The cabin of the Penguin is heated and the whole snowship is watertight, not with a view to incarcerating human Laikas, but so that the tractor can serve at need as an amphibian.

"Gum-pot" fabrics spread

STICKING fibres together instead of weaving them has gone a long way since it was regarded by the Americans about 10 years ago as suitable only for producing a superior material to compete with paper. A selection of clothes, shoes, artificial flowers, bookbinding and filter materials and leather-cloth has lately been on exhibition in Manchester to show how wide is the sphere of application for bonded fabrics, including certain uses in cable-making, battery manufacture and even funeral furnishing.

There is now special machinery to form the synthetic fibres into fibrous webs of various patterns and to apply suitable and durable bonding agents to them. Although the greatest use for these fabrics is in clothing, one of the most interesting applications is in filters where the uniform distribution of the fibres gives specially good results.

Theoretically, paper has an equally good distribution of fibres, but the process of making paper appears to lead to poorer porosity. Bonded fibre fabric has given excellent service in filtering heavy liquids like diesel oil, acetate dope, electro-plating solutions and milk.

The recent exhibition was arranged by Bonded Fibre Fabric, Ltd., formed in 1951 as a subsidiary of Courtaulds, Ltd.

Metal working operations taped

AUTOMATION through electronics is beginning to invade the machine tool industry. A flame cutter for steel plates traces out the desired profile according to instructions issued by a magnetic tape "briefed" by a computer (see *The New Scientist* 28 November, p. 23). Another newcomer is an electronic system using an analogue interpolator which works in conjunction with a milling machine to produce master cams, templates or finished parts, however intricately shaped, with speed and precision.

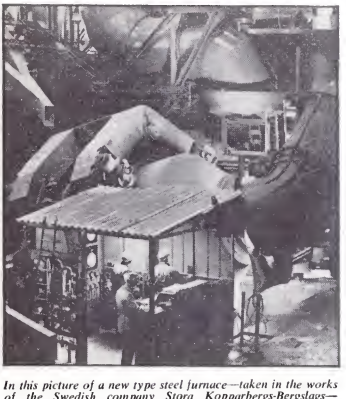
This second form of control, developed by E M I Electronics, Ltd., also relies on the use of punched tapes, but in this case the computer which normally prepares the tapes has been eliminated. Instead, the programme, which consists of the coordinates of a relatively small number of points on the blueprint, is worked out by the designer. The interpolator accurately defines the contours of the workpiece between these marker points. It does so by fitting part of a parabola to groups of three points at a time.

In operation, a modified teleprinter is used to transfer the table of dimensions on to the tape. The tape is fed through a reader into stores where voltages proportional to the coded figures are set up. The interpolator, drawing on the information in the relay store, specifies the position of the workpiece at any given moment. An error in positioning is immediately shown up by a difference in this "command" voltage and the measuring voltage of the analogue units that are linked to the machine table and head. Such an error signal in turn actuates the servo motors or hydraulic valves to make the necessary adjustment.

Among the equipment available with this type of control is the vertical milling machine manufactured by C V A Jigs, Moulds and Tools, Ltd., under licence from the American company Kearney and Trecker. The cost of the electronic installation varies between £8,000 and £10,000, depending on the ancillaries, but it is reported to result in economics of up to 80 per cent. in machine time.

SCIENCE IN INDUSTRY *continued*

Steel-making by Kaldo process



In this picture of a new type steel furnace—taken in the works of the Swedish company Stora Kopparbergs-Bergslags—gigantic ducts for automatic charging, blowing and exhausting tend to dwarf the cylindrical furnace and its tapered nose. Part of it can be seen over the roof of the control hut. It is grasped by the converter stand which tilts it at need and incorporates the apparatus for spinning it at any rate up to 30 r p m during the melt. Through the nose a water-cooled lance blows oxygen on to the surface of the metal. A hood which shrouds the lance conducts fumes and dust into the duct leading to a water-cooled stack. From bunkers above the furnace, lime additions and ore for cooling can be delivered at the right moment and in proper quantities. While blowing is going on, the tilt and the spin ensure the requisite stirring effect in the metal. This now ranks as a relatively small furnace. Its capacity is 30 tons. Others working on the same principle will deal with 100 tons. This Kaldo furnace, designed and made by B A M A G of Cologne, can be supplied in this country by Head Wrightson Iron and Steel Works Engineering, Ltd.

When beans can be canned

TINNED broad beans frequently tend to lose their fresh appearance and assume an unattractive brown or grey colouring. Now a test has been devised which, whether applied to seed or mature bean, will tell the manufacturer if a particular variety is suitable for preservation by canning.

The test is based on the assumption that broad beans contain varying amounts of certain chemicals belonging to the family of leuco-anthocyanins which, on heating, partly decompose and partly react to form brown polymerisation products. From this explanation of the origin of those undesirable colour changes, it follows that the detection of leuco-anthocyanins condemns the bean under test as unsuitable for canning.

The method consists in extracting the chopped skins from two or three beans with methyl alcohol. A portion of the extract is then heated with a mixture of hydrochloric acid and butanol. If a red colour develops, the beans contain leuco-anthocyanins.

The reliability of the test has been checked and confirmed. For example, a completely negative result was obtained with Triple White, a white-flowered variety which is known to retain its healthy pale green hue after processing. This work, described in *Chemistry and Industry*, has been carried out by the Fruit and Vegetable Canning and Quick Freezing Research Association. Similar investigations with other vegetables and fruits are now in progress.

Jacking up the bridge

THE work of raising several of the spans of the Jacques Cartier bridge at Montreal (to which reference was made in *The New Scientist* of 29 November, 1956) is now under way. Special hydraulic jacks made in England are being inserted between pier and span to raise the span structure 6 in. at a time.

At each 6-in. lift, concrete blocks are inserted between pier and span to serve as bases for the next lift. When the lift amounts to 2 ft. a crown of concrete of that depth is put on the pier. In this way, the span which has to be raised most will ultimately be lifted 60 ft. and others on each side of it will be raised in such a way as to give an inclined approach to it.

This work is to give clearance for shipping in a new channel of the St. Lawrence which is being dredged as part of the St. Lawrence seaway scheme. The whole job on the bridge will occupy about two years and should be achieved without any appreciable interruption of traffic.

Towards unshrinkable wool

MOST countries interested in wool production are continuously on the look-out for effective methods of making woollen fabrics unshrinkable. Many of the processes so far devised for this purpose have involved the use of resins. Now research sponsored by the U S Department of Agriculture has led to a new version of that well-tried technique, combining a polyamide with epoxy-type resins.

Like its predecessors, however, it makes the treated cloth rather stiff and harsh to the touch.

In this instance, carefully controlled amounts of the mixture are sprayed on to the material which must previously have been conditioned by simple wetting and drying. By experimenting with other resins and other processing conditions these workers hope to follow up their initial success and find a way of giving the fabric the desired property without impairing its "handle." Treating a woollen sweater, for example, might cost about 4½d.

THE life of Sir James Wordie has been lived in two worlds: in the sheltered courts and the easy, expansive environment of St. John's College, Cambridge; and in the wind-swept, ice-buried continents at each end of the Earth, where comrades may have to be cooped in one small hut for the whole of a winter's darkness.

If found in the Master's Lodge at Cambridge, where the great refectory table seems always to be struggling out from under a recently-descended avalanche of books, he looks very much a College man. It is forty-seven years since Sir James first entered St. John's and became, in turn, Fellow, Tutor, Senior Tutor and President. Five years ago the College Fellows chose him to succeed Ernest Benians as Master. Small, deliberate, professorially shy, he speaks of the College with restrained but unashamed enthusiasm. "It's a fine place to be . . . large and progressive . . . so many Fellows, each an expert in his line."

But it is not as the Master of St. John's that Sir James Wordie has lately come into the public view. It is as an elder statesman of polar exploration. Nearly one-third of the £650,000 that Parliament has granted towards the British scientific efforts for the International Geophysical Year has been spent on sending research teams into the Antarctic. Sir James is chairman of the British National Committee, chairman of the Antarctic Sub-committee, chairman of the Antarctic Personnel and Training Sub-committee, chairman of the Publicity Sub-committee, and a member of the sub-committee for the liaison with the Commonwealth Trans-Antarctic Expedition.

Obviously, among the experts on polar exploration and research his opinions are highly valued. It was Wordie who, over the past three years, has been largely responsible for the selection of the teams sent to Halley Bay. It was Wordie who was consulted about which type of ships to use, about the route they should take, about the date they should attempt to make a landing. Yet this reputation has been built without any wide public notice. The reasons for that are in his nature.

Sir James was born in Glasgow, sixty-eight years ago, the younger son of a well-known haulage contractor. From childhood his taste for exploring the difficult and the inaccessible was developed, for his father's library had a fine collection of books on travel and on mountains and mountaineers. As a younger son he was spared from the family business, and he went instead to Glasgow University to take a mixed degree in classics and science.

He studied geology under Professor J. W. Gregory, who in the years before the end of the century was making solitary geological journeys into East Africa. These were the days before British rule, when the Masai were amongst the most savage tribes in the world, and Gregory used to sleep in a deck chair every night, to be more certain of seeing the dawn. To do field work with such a man, even if only in the Scottish Highlands, was bound to foster the ambition already growing in the mind of the young James Wordie. And when he went to Cambridge in 1910 he was searching for the opportunity to go on a major voyage of exploration. The chance was soon to come.

In 1914 Sir Raymond Priestley, who had recently returned from Scott's last voyage, got Wordie a place with the Shackleton Trans-Antarctic Expedition as the party's geologist and chief of scientific staff.

The story of that journey has been told often enough not to need repeating. But Sir James's own description of it is worth giving, as it shows very clearly his attitude to heroic dramatization. "We spent the first year very comfortably aboard the *Endurance*, as, trapped in the ice, she drifted north-westwards across the Weddell Sea. The second winter we spent rather less comfortably, as shipwrecked men on Elephant Island."

Pressed for details of those long months of waiting, he might add, "The high winds made it impossible to continue living in tents and we turned the ship's boats over to make two-storey dwellings. We stuffed the cracks, used tent fabrics for side walls, and killed seals and penguins for food.

"Geologically, we had to confine our research to examining the contents of penguins' stomachs. They have a grinding mechanism in their crop and large pieces of rock can be recovered. Our findings were much as we expected: we found standstone and granite, indicating that the rocks were much the same as those round the Ross Sea and quite different from those of Graham Land, which is an extension southwards of the folded mountains of the Andes.

"No, we did not worry about our fate. No one doubted that Shackleton would see us through. He was a great leader and inspired complete confidence."

PROFILE Sir James Wordie

Exploration's elder statesman

His words bear out the opinion of Shackleton quoted by Sir Raymond Priestley: "As a scientific leader give me Scott; for swift and efficient polar travel, Amundsen; but when things are hopeless and there seems no way out, get down on your knees and pray for Shackleton."

The experience gained on this trip of the ice movements in the Weddell Sea has proved invaluable during the past three years. There were many who thought that, far from succeeding in crossing the Antarctic continent, it would not even prove possible to set up bases on the shores of the Weddell Sea. Sir James believed, confidently and tenaciously, in the view that, although the *Endurance* had been caught and crushed, it had been also observed that the merciless pack-ice in this region is always moving, and in January and February there is certain to be free water in the Halley Bay region. The pack-ice is blown away from the coast. It was this knowledge that made the establishment of the bases at Halley Bay and at Shackleton possible, the latter giving the Fuchs expedition a route across the Antarctic continent not nearly as long as the other alternatives.

That long wait on the ice also taught Wordie much about the psychology of polar exploration. Life in the frozen regions involves frantic periods of activity when setting up camp, followed by prolonged and almost complete inactivity during the months of darkness. In such conditions mannerisms and idiosyncrasies which would normally hardly be noticed can become sources of friction. Talking of the problems of selecting teams for polar research for the current expedition, Sir James has said: "We chose the men who had the best scientific qualifications and who we also thought would get along together. We relied on their having the intelligence and the character to be able to adapt themselves to Antarctic conditions once they arrived. There was no lack of applications. We had almost four times as many volunteers to Halley Bay as there were places to fill."

Sir James returned from the Shackleton journey in time to join the Army and become a casualty in World War I. He was sent home from the Belgian sector, but within a year of his return to England the war was over and he was exploring again.

In 1919, W. S. Bruce, the man who had been talking about the possibilities of a Trans-Antarctic crossing as early as 1908, asked Wordie to accompany him to the Arctic as second-in-command. On this expedition to Spitzbergen he took parties of students from Edinburgh and Glasgow, and it became the forerunner of the expeditions which are now quite a usual feature of university life.

It had been hoped that there would be oil deposits in Spitzbergen, but the scent that Wordie found everywhere was the familiar scent he remembered from Broxburn in his native Scotland: the unprofitable smell of oil shale.

In the 1920s he made four expeditions to East Greenland and Jan Mayen Island. Encouraged by him and his contemporaries a new school of polar explorers was developing. Outstanding amongst them was Gino Watkins, who was to become one of the most famous leaders since Scott. In 1927, after coming to Priestley, Debenham and Wordie for his "A B C" on the organisation of a polar expedition, Watkins made his first journey to Edge Island. Later, in Greenland, he worked Eskimo fashion, using kayaks and husky teams. By the time he lost his life seal hunting, in 1932, Watkins had done much to rehabilitate the reputation of British explorers which had suffered a great deal after Amundsen's triumph at the South Pole.

In 1929 another young man, also a student of geology at St. John's College, made his first trip to the frozen North. He went with Wordie to Petermann Peak in East Greenland. His name was Vivian Fuchs.

In the 30s Wordie made two more summer voyages to the Arctic, to North ,West Greenland, Ellesmere Island and Baffin Land. And in 1947, at the age of fifty-eight, he made his last trip to the Far South, to the South Orkneys, to Graham Land and to the South Shetlands.

That, after thirty-three years, was the end of his work in the field. He was to remain chairman of the Scott Polar Research Institute for a further eight years, to make his full term as its chairman eighteen years in length.

Sir James was married in 1923 and has five children. His three sons have followed widely differing professions, but none has followed his father's footsteps towards the extreme Poles: one is a barrister, one a farmer in Scotland, one in shipping.

The planning of the immense programme of work for the I G Y began five years ago. It has meant frequent committee meetings, scores of interviews, travel to Rome, Brussels and Paris for meetings with representatives of other participating countries. Sir James himself shuns any credit. "The Royal Society has an expert staff for co-ordinating the work of the countries involved. I cannot speak too highly of them," he will say, or "The work is split between the various branches of science . . . my share is very light."

There are some men who, holding such an office in such a year, would have made their names household words by now. Sir James Wordie is not one of them. On the subject of himself he would probably prefer that nothing were said at all. He would certainly be the last to say that undergraduates, polar explorers, the world at large or anyone at all, owes him anything. But his colleagues know that the debt is there—and growing.

AMERICAN NEWSLETTER

President Eisenhower's illness

From JOHN LEAR, our American correspondent

NEW YORK.

PRESIDENT EISENHOWER'S cerebral accident seems to have resulted in nothing more serious than an apparently slight transitory aberration in his speech. If this is so, nerve surgeons who specialise in mapping the brain know exactly where the mishap occurred. It happened in a tiny convolution of the frontal lobe in the left hemisphere of the brain—the so-called dominant hemisphere for a right-handed man. This miniature valley is called Broca's convolution because the French surgeon Paul Broca discovered in an autopsy in 1861 that if the walls of the valley in a normal brain were scarred by injury, the ability to speak would be lost without the loss of any other ability.

It is historically interesting that Broca's convolution was the very first site in the brain to be clearly identified as the control point of a particular function in the human nervous system. It is even more interesting that President Eisenhower should have suffered a momentary interruption of the supply of oxygen through his blood to his brain at this particular spot just a week after some fascinating new research touching upon it had been reported to a meeting of the National Academy of Sciences.

The report was made by Dr. Wilder Penfield, director of the Montreal Neurological Institute in Canada. I have written about him in an earlier column in *The New Scientist*. He has been working on brain geography for a long time, using as his major tool an electrode charged with very weak electrical current. By opening the skull and touching the electrode to various points in the brain cortex it is possible to locate and surgically remove lesions which cause attacks in certain forms of epilepsy, since the brain itself feels nothing. The exploring is done while the patients are fully conscious, and can not only react but explain their reactions.

★

IN the course of his mapping Dr. Penfield has come across—in a region of the brain to which no special usefulness had been attributed previously—what he believes must be the source of all our judgments. Apparently we decide what is good or bad, ugly or beautiful, pleasant or unpleasant, by making lightning-fast comparisons between the impressions of our sense organs in the immediate present and a stream of consciousness, a news-reel of our past, which the brain in some mysterious way adds to continuously and re-runs on demand. The pictures on the reel are different from memory in that they are much more detailed; they record only those events which are consciously recognised as important at the moment of occurrence . . . whether trivial or crucial in reality. When the events are brought back into the consciousness by the touch of Dr. Penfield's electrode, patients in whose minds they are stored feel that an experience is being re-lived rather than merely being recalled. Music heard at some time in the past is reproduced in full tone, for instance, so that patients can hum or sing tunes they cannot recognise or identify.

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THE part of this research which can be associated with President Eisenhower's cerebral accident is the mapping of Broca's convolution. When Dr. Penfield placed his electrode on the wall of this miniscule valley, patients were silent: no words were suggested to them, no speech was recalled from the past. When patients were asked questions while the electrode was at that point they could not answer; they could not find words to express their thoughts. When the electrode was lifted, however, words came with a rush, quickly expressing previously conceived, but unexpressable answers.

There is at least a conceptual similarity between this artificially induced expression and Vice-President Nixon's description of President Eisenhower's speech aberration: "He was irritated that the words did not come quite as fast as they usually do." Mr. Nixon told reporters: "It was not a case of any inability to formulate ideas; in fact, the ideas were ahead of his speech—that was quite obvious . . . the only problem the President was having was a hesitancy in finding a few words . . . just a hesitancy before using the words which he wanted to use. . . ."

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WHAT would seem to have happened to the President, then, was interruption of the blood flow which disturbed the electrical signals through which the brain translates ideas into words. Regardless of the silly headline argument about it, this was of course a "stroke"; and again, despite the absurd claims of the White House coterie, the "stroke" was a natural and normal aftermath of the Presidential heart attack in September, 1955. Those physicians who pointed out the expectability of it two years ago—and were attacked as "political partisans attempting to influence the Presidential election of 1956"—have been entirely justified.

The announcement that Mr. Eisenhower is not afflicted with general arteriosclerosis was in itself a doubtful statement, because almost all people of his age have in greater or less degree hardening of the arteries. The official phraseology can be excused only on the ground that the President's real trouble is atherosclerosis—a formation inside the artery walls of cholesterol deposits which tear off and form blood clots.

ATOMIC SCIENCE SECTION

How plants grow: a study made possible by carbon-14

By growing plants in an atmosphere of radioactive carbon dioxide plant physiologists have unravelled the mystery of photosynthesis. Now they are trying to find how chlorophyll, the dye necessary for photosynthesis, is formed

by Dr. HELEN PORTER, F R S

THE major constituents of plants are carbohydrates, proteins and fats. They are built up from carbon dioxide in the air which enters by the leaves, and from water and simple compounds of nitrogen, sulphur and phosphorus which enter through the roots. The carbohydrates, which contain only carbon and the elements of water (hydrogen and oxygen), make up 75 per cent. of the plant substance, and carbon alone, which is combined in all plant products, accounts for 30 to 40 per cent.

An understanding of the way in which carbon atoms contribute to the formation of the large aggregates of atoms (molecules) and so to the continuous accumulation of material as growth proceeds, is a matter of primary importance to agriculture because the efficiency and regulation of the very complex processes involved determine all crop yields. Classical methods of organic chemistry have elucidated the structures not only of the three major plant constituents but of many others which are found in relatively small amounts but are none the less important, and so has taught us what are the final products of growth.

It is to the study of this, which might be termed the molecular aspect of growth, that the use of isotopes can contribute so much. By substituting some of the atoms by others which are chemically identical, but radioactive, it should be possible to follow their course through the numerous stages from the simple starting molecules, containing few atoms (3 to about 15), to completed molecules which may contain hundreds. Thus we should be able to obtain a much deeper insight into the building process.

There are now available isotopes of all the six elements which combine to form the carbohydrates, proteins and fats, so eventually it should be possible to follow the pathway of each one. Many technical difficulties will have to be overcome before this goal is reached, but there is no doubt that a new era of research has been opened up into the chemical processes of living matter.

Green plants are characterised by their high content of carbohydrate and are unique in the living world in possessing the capacity to transform carbon dioxide to carbohydrate by the process known as photosynthesis. In this way the basic foodstuff of man and animals is produced. Thus, it is hardly surprising that a great deal of attention has been paid to the use of carbon isotopes as research tools.

It is fortunate that one of the carbon isotopes, carbon-14, is not only radioactive but has a very long half life; it takes more than 2,000 years for half of any quantity of carbon-14 to disintegrate. This means first that very small amounts can readily be detected with suitable counting equipment, and secondly that no measurable fall in activity will occur during experimental periods covering the whole life cycle of crop plants.

Another advantage is that the type of radiation emitted is such that quite simple precautions suffice to ensure that there is no health hazard to the worker. Finally, it is possible to carry out important studies with carbon-14 on the laboratory scale, using quite small amounts of plant tissue.

The easiest way of introducing carbon-14 into plants is to expose the leaves in the light to radioactive carbon dioxide, when carbon-14 becomes incorporated into carbohydrate by the normal photosynthetic reactions. As far as is known low levels of radiation do not alter this process, but high levels do result in damage to plant cells and must be avoided. It is clear that if seedlings are grown continuously in an atmosphere containing radioactive carbon doxide all the plant constituents will become radioactive or "labelled" with carbon-14. A method is thus at hand for preparing in a radioactive form any desired natural product from the plant kingdom.

Special equipment is of course required to confine the air containing the "labelled" carbon dioxide, and to control its amount and activity. At the Argonne laboratory, near Chicago, large chambers have been built for this pur-

The special Atomic Science Section appears in every fourth issue of this magazine. It is compiled by "The New Scientist" editorial staff in collaboration with the Atomic Scientists' Association. This week the section is devoted to the striking advances in agricultural research through the use of radio-isotopes.

HOW PLANTS GROW *continued*

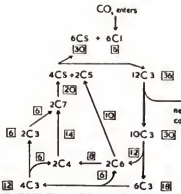


FIGURE 1. *The carbon cycle leading to formation of carbohydrate from the carbon dioxide of the air. Number of carbon atoms used at each step shown in squares. Number linked together in the substances formed shown as subscripts to letter C. Each substance contains hydrogen, oxygen and phosphorus, as well as carbon.*

pose and numerous "labelled" plants raised. From some of these plants have been extracted drugs such as nicotine, morphine, and those of the digitalis group. These radioactive preparations have been used for new investigations into the effects of such drugs on the animal body. A further use of the chambers, among many others, has been to find out the upper limit of radiation beyond which distortion of growth occurs.

It was at once recognised that the advent of carbon-14 provided a new approach to the investigation of photosynthesis itself, that is the combining of carbon dioxide with the elements of water to form the simplest carbohydrate unit, a sugar, in which six carbon atoms are joined together. All carbohydrates are derived from this basic six-carbon unit, for example by linking up two such units, which produces the sugar of commerce (cane sugar or sucrose), or by the linking of many, which produces cellulose and starch.

More has been learnt about the primary formation of the six-carbon chain in the past decade, using carbon-14, than in all the years since the first discovery, in about 1780, that the carbon dioxide of the air supplied the material for plant growth. A concentrated and brilliant piece of team work by American scientists has mapped out the "Pathway of carbon in photosynthesis."

The important discovery is that the formation of the new six-carbon chains does not come about by joining six new atoms derived from the carbon dioxide together, but requires a complex cycle of events involving in all 36 carbon atoms to produce one new six-carbon unit.

Each carbon atom entering the leaf is first joined to an existing molecule containing five carbon atoms and in this way two molecules each containing three carbon atoms are produced. The first step is therefore the production of 12 of these three-carbon molecules, all alike. Two of these join together to provide one new unit, and the other ten undergo a cycle of changes forming and splitting chains with varying numbers of carbon atoms, until finally six molecules of the five-carbon compound are reformed ready to start another cycle.

An outline of the cycle is presented in Figure 1, taking account only of the conversions of the carbon atoms, to show how the ten three-carbon molecules are reformed into six five-carbon molecules. The whole procedure is very rapid, but using carbon-14, all the products formed in periods of time as short as one second can be identified, and so bit by bit the whole sequence of events has been revealed. While the last word has probably not yet been said about the intricate details of this fundamental living process, a new impetus has been given to the investigations.

Since the plant has discrete growing points much of the material made by a single leaf must be moved to sites of growth elsewhere. Radio-carbon enables us to find out how fast this material moves, to trace the channels of its movement and to identify the actual substances which move. Rate of movement in the plant turns out to be about six inches in 15 minutes, which means that in most agricultural crops newly formed carbohydrate from a leaf reaches the growing points at the top in

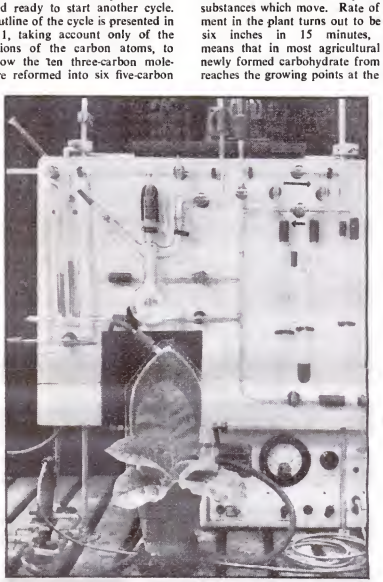


FIGURE 2. *An apparatus for circulating radioactive carbon dioxide over one leaf of a tobacco plant.*

about 30 minutes, or less if one considers its path from nearby leaves.

To trace the movement a single leaf, or just a small area of one leaf, is exposed to radioactive carbon dioxide for a short time, say an hour, and the distribution of radioactivity then determined after a further period of time, as the substances containing the radio-carbon move about the plant. A picture of an apparatus for carrying out this type of experiment is shown in Figure 2.

The distribution can often be observed by means of an autoradiograph. Radiation will blacken X-ray film; by laying parts of the plant on a sheet of film the areas of activity are recorded as black patches. An autoradiograph of a bean plant in which the leaves were given carbon-14 and the picture taken after an hour is shown in Figure 3. Rapid movement up to the growing points can easily be demonstrated in this way, and many other interesting details have been observed.

For example, as well as going upwards, material passes rapidly downwards even to the smallest roots, but on the way does not pass into any leaf below the treated one, nor does it pass into all the leaves above on the way to the tip. An elegant method is thus at hand for mapping out the intricate arrangement of conducting channels.

This type of experiment also enables us to study in detail the way in which that part of a plant which forms the crop required by man acquires the necessary supplies for its growth. Russian scientists have made an extensive investigation of sugar beet, by exposing leaves to radio-carbon at different times throughout the growth cycle. They proved that all the sugar (sucrose) was made in the leaves and moved unchanged to the root where it accumulated; virtually none was made in the root itself.

They also report that bean pods depend upon immediately adjacent leaves for their carbon supplies: when leaves remote from a particular pod were given radio-carbon, this pod did not become radioactive, that is, it received no material from the remote leaf. As a further example—it has been found that in the potato plant, sugar made in the leaves does not pass into a common channel which supplies all tubers alike with starch forming material. Particular leaves supply particular tubers.

FIGURE 3. *Autoradiograph of a bean shoot showing distribution of radioactivity after exposure of the leaves to radioactive carbon dioxide for an hour.*

While the first stages of synthesis have been defined by using labelled carbon dioxide, it is obvious that later transformations cannot be followed if all the carbon atoms become labelled and so indistinguishable one from the other. Progress can be made in some cases by isolating plant leaves, stems or roots, or pieces of these tissues and supplying them with ready-made radio-sugars.

This method has been specially useful in work on starch and sucrose synthesis. Leaf cells, in the dark, can use a number of simple carbohydrates, turning them into starch and sucrose, and also turning them back to carbon dioxide by the process of respiration. It has been shown by means of radio-sugars that to do this the starting material, whatever it may be, is first converted into some common form and only then can it take part in further growth processes. One of the unsolved questions at present is the precise nature of this necessary intermediate form.

The analysis can be carried yet further, and we can enquire not only how a whole carbohydrate unit is used, but what happens to each of the atoms of its six-carbon chain. To do this the skill of the organic chemist must be invoked to make a six-carbon sugar, usually glucose, in which only one of the carbons is radioactive.

Since plants develop from a single cell resulting from sexual union, in the early stages of seedling growth they must depend on substances contained in the seed, because photosynthesis cannot begin until there is at least one green leaf. At this stage there is very rapid formation of cellulose, which is made up of a large number of six-carbon glucose units joined together. By feeding radio-glucose in which only one carbon atom is radioactive through the roots of cereal seedlings the cellulose can be made radioactive. However, after this synthesis has taken place the glucose units combined in cellulose are found to have two carbon atoms radioactive, so that during the process the chains of six-carbon atoms must have split in half and reformed.

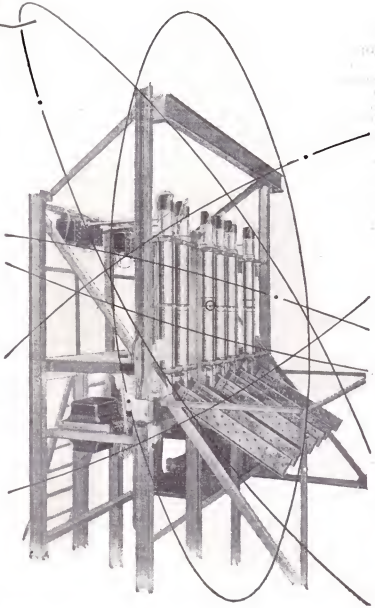
After large molecules such as cellulose and protein have been formed the question may be asked, "How long do they last?" When, for example, leaf growth is complete do these molecules continually break down and reform, or do they remain unchanged until the leaf dies? Preliminary results of isotope experiments suggest that there is continuous change, very slow in the case of cellulose, but faster in the case of proteins.

Many other examples can be cited of the way in which isotopes are helping us to understand plant growth. Among problems under study are the mode of formation of the vital green pigment chlorophyll; the movement of materials across grafts; and the fate of herbicides sprayed on leaves.

This article has been restricted to discussing some of the important and interesting questions that radio-carbon is now helping to answer. No mention has been made of the isotopes of nitrogen, hydrogen and oxygen. Nitrogen-15 is rapidly coming into use, making possible a host of new researches into such problems as to the position of the major site of the union of nitrogen coming from the roots and carbon coming from the leaves; namely the starting point of protein synthesis.

The hydrogen isotope, tritium, and the oxygen isotope, oxygen-18, offer the possibility of investigating the part played by water in plant syntheses. While at present some of the researches may seem a little remote from the immediate problems of agriculturists, there can be little doubt of the value of the increased knowledge being gained about basic growth mechanisms.

A step in a nuclear direction



H. M. HOBSON LTD. have for many years specialised in the design and manufacture of aircraft components calling for the highest degree of ingenuity and precision engineering. Although these activities continue in full swing, the Company have now entered the nuclear field and are engaged in the design and production of reactor control components and other ancillary equipment in collaboration with the Atomic Energy Authority. These items include the control systems for the following important Research Reactors: E.443 (Dido) for Harwell, A.E.443 for Sydney, Australia, and the R.E.775 (Pluto) for Harwell and Dounreay. Design, development and manufacture is proceeding on an automatic machine for introducing isotope specimens into the reactor and removing them after the requisite irradiation time ; precision small pressure vessels and other experimental equipment for testing samples of various materials in the reactors ; and control mechanisms for a new zero energy reactor.

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PLANT NUTRITION STUDY WITH RADIOACTIVE TRACERS

Isotopes have a big part to play in elucidating the problems of plant nutrition, from the viewpoints of both the soil chemist and the plant physiologist. Their use has already changed long-accepted views

by Dr. R. SCOTT RUSSELL

THE study of plant nutrition falls within the province of two scientific disciplines which have frequently had little contact one with the other. There is the approach of the soil chemist who analyses soils and plants and makes practical recommendations to the farmer—the widespread use of artificial fertilisers is a measure of his success. There is also the approach of the plant physiologist who often gives little thought to relationships between plants and the soil in which they grow, and chooses isolated fragments of tissues as the material for his investigations; our understanding of the mechanisms whereby plants absorb nutrients is based largely on information gained in this way.

It is, however, becoming increasingly apparent that the contribution of both viewpoints will be necessary if an adequate analysis of many plant nutrition problems is to be achieved. Particular interest, therefore, attaches to advances in technique which facilitate the analysis of nutritional problems in terms of the behaviour of the nutrient both before and after it crosses the interface between the soil and the plant. In the recent past the use of radioactive isotopes as tracers has proved particularly valuable from this viewpoint. The object of this article is to indicate the types of new information which can be obtained by their use.

Many of the substances of greatest importance for the nutrition of plants, for example phosphates, exist in a large number of different forms in the soil, but the majority of them are not accessible to the absorbing roots of plants. The soil chemist is faced with the difficult problem of identifying the fraction on which plants feed. This is not merely a matter of measuring phosphate ions which are in solution in water in the soil; "labile" ions, loosely held on surfaces from which they can readily be displaced, may be equally important.

For many years various analytical procedures in which soils are extracted with dilute acids or other chemicals, have given information of much practical value. However, these methods are empirical and they are of far from universal application. If two soils of contrasting type are examined by the same chemical procedure, the results obtained may bear no relationship to the relative amounts of the nutrient which plants will absorb from them. This is because the extraction procedures bring about chemical changes in the soil. For the purpose of studying the availability of nutrients to plants the ideal method would be one in which the "lability" of different fractions of nutrients in the soil could be measured without the chemical composition of the soil being altered.

One way of obtaining useful information is by the study of "isotopic exchange." Suppose a sample to which nutrient ions are loosely attached is placed in a solution containing a radioactive form of the same ion. Some of the radioactive ions change place with the attached ones. When equilibrium is reached the ratio of radioactive to ordinary ions will be the same in the solution and on the surface of the sample. If the quantity of the radioactive isotope introduced into the system is known it is therefore possible to determine the extent of exchange by analysing the solution.

The rate at which equilibrium is attained depends on the manner in which the exchangeable ions are held on the solid. The more loosely they are held the more rapid the exchange reaction; those which are more firmly held will exchange more slowly. The rapidly exchangeable ions—those which are most labile—are those which will be most accessible for absorption by plants. Much information can therefore be obtained by studying the time course of isotopic exchange.

The two plant nutrients which have been studied most extensively by isotopic exchange methods are phosphate and calcium. With phosphate a rapid initial exchange reaction occurs, but it is followed by a slower process which may not be complete for several weeks. (Fig. 1) This proves that the "labile" phosphate in the soil is not all held in the same way.

In most soils calcium shows no comparable slow secondary reaction after the initial rapid exchange; in some soils, however, a slow process follows the initial rapid one, as with phosphate, though its relative magnitude is very much smaller. A comparison of the isotopic exchange curves for different soils or for fractions of a single soil which have been subjected to different treatments can therefore provide information on the physico-chemical behaviour of nutrients in soil and on the factors which affect it.

In the years immediately after the second World War, when the opportunity first existed for applying tracer methods to agricultural problems on a large scale, many experiments were carried out to determine how much of the nutrients absorbed by plants came from fertilisers and how much from the soil.

PLANT NUTRITION STUDY *continued*

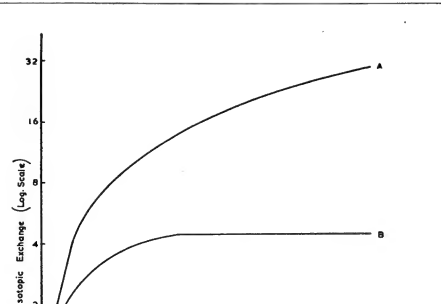


FIGURE 1. *Diagram of relationship between time and the extent of isotopic exchange. (A) A fast exchange reaction (represented by the initial steep part of the curve) followed by a slower exchange reaction. (B) A simple exchange reaction which rapidly attains equilibrium, the curve then becoming horizontal. Exchange curves for phosphate in soils resemble "A."*

For this purpose "labelled" fertilisers were incorporated in soil. It was soon realised, however, that this was not the most important question; fertilisers lose their identity when added to the soil because they exchange ions with nutrients which are already present.

Therefore the question of real interest is not "How much of the nutrient absorbed by the plant came out of the fertiliser itself?" but "How big is the nutrient pool in the soil, and how much is it increased by the addition of fertilisers?"

If a given quantity of a nutrient labelled with a radioactive isotope is added to a soil and plants are grown in it then some of the labelled ions are absorbed by the plants. Apart from their radioactivity the labelled ions are identical with the ordinary ones in the soil. Thus, provided they have reached equilibrium and are thoroughly mixed, the sample of nutrient entering the plant should contain the same proportion of radioactive ions as the rest of the nutrient "pool." If we measure this ratio and know the total quantity of radioactive nutrient added, we can work out the size of the labile nutrient pool accessible to the plant. This quantity is appropriately described as the "L" value; the method was pioneered by Dr. S. Larson, and it gives a measure of the quantity of nutrients which are sufficiently labile to exchange and reach equilibrium with the tracer. When the method which is known as "isotopic dilution" was first developed it was hoped that here at last was a way of comparing the quantities of nutrients which different soils could provide to plants. This possibility has been investigated particularly with regard to the availability of phosphate to plants.

Unfortunately, we now know that although the "L" value often provides information on this question it cannot be used to compare the relative capacity of very contrasting soils to provide phosphate to plants. Some soils, described as "phosphate-fixing" have been shown to have large "L" values even though plants can absorb little phosphate from them. It is now being realised that two parameters are needed to describe the availability of nutrients to plants—the "quantity" of nutrient in the labile pool and its "potential." Solid surfaces which hold labile ions relatively tightly will cause the potential to be reduced.

The plant can benefit from a nutrient only if it is able to hold ions more tightly than the soil from which it takes them. Thus even if there is a large quantity of labile ions in the soil (a large "L" value) plants will absorb little if the potential is too low. Methods for measuring this all-important quantity are still not fully developed, but the use of radioactive tracers has already added considerably to our general understanding of the subject.

Tracers have been used also in many studies of more practical aspects of the nutrition of plants grown in soil; for example, by applying labelled nutrients at different levels in the soil the relative extent to which different parts of the root system of a plant absorb nutrients can be assessed. Information thus obtained can guide fertiliser practices.

More space has been given in this article to the soil problems than the physiological aspect of plant nutrition, because the manner in which tracers are used in physiological work is closely similar to that illustrated in the companion article on plant metabolism by Dr. K. H. Porter.

A particular advantage of tracer methods for the plant physiologist interested in plant nutrition is that, in a suitably planned experiment, he can observe the rate of movement of ions in one direction across an interface even though a large number of ions of the same type are moving in the opposite direction.

Tracer methods have shown that a significant fraction of ions in plant roots, especially positively charged ions like potassium, may be readily exchangeable with those in the outer medium. Outward and inward passage may occur simultaneously.

Detailed studies of such effects have greatly modified our picture of the initial phase of the entry of ions into roots. At one time it was thought that the outer surface of the plant cell was a barrier across which ions were moved only by virtue of the expenditure of energy. Now it is widely believed that quite a large proportion of the cell cytoplasm is relatively accessible to ions from the exterior.

Ions such as phosphate, which are highly reactive in biochemical systems, have been shown to enter at dramatic speed into complex reaction sequences. The sensitivity of tracer methods combined with the method of separating substances known as partition paper chromatography has made it possible to show that within fifteen seconds of entering roots significant quantities of phosphate can be incorporated into organic compounds, particularly nucleotides.

Less progress has been made in interpreting the mechanism whereby ions are actively transported across the cytoplasm of a cell and released into the vacuole—the central cavity filled with water and dissolved substances—or across the roots of plants into the sap which carries them to other parts. It is well established that both processes depend on the expenditure of energy derived from respiration; the concentration in cell vacuoles or in the sap rising from the roots may exceed that in the outer medium many times, sometimes more than one hundredfold. The opportunities which tracer methods provide for making observations over short periods in plants subjected to widely varying concentrations have added much to our knowledge of the characteristics of this process; theories have multiplied. But no detailed interpretation, as yet advanced, has won general acceptance.

Radio-isotopes as an aid to the animal physiologist

They enable him to tackle problems previously insoluble—such as investigating the effects of certain chemicals on the thyroid, the absorption of vitamin B_{12} by the intestine, and the origin of fat in milk

by Dr. R. F. GLASCOCK

EACH year sees the publication of more and more papers describing work carried out with the help of isotopes used as "tracers." Much of this work is highly specialised and deals with the finer architecture of biochemical reactions: with finding out how one compound is converted into another; or even with the way in which biochemical intermediates are oriented on the enzymes promoting the reactions. This type of work is beyond the scope of this article. It is proposed instead to describe other more easily understood problems which isotopes are helping to solve and for which they are often uniquely suitable.

The metabolism of iodine. Iodine is a biologically important element mainly because it is contained in *thyroxine*, the secretion of the thyroid gland. A deficiency of iodine results in a shortage of thyroxine, an enlargement of the gland and other symptoms typical of the disease called goitre. There are several radioactive isotopes of iodine, of which the most useful is iodine-131, which is produced as a by-product of the atomic pile. This isotope has been in the news recently as one of the chief causes of contamination of milk in the neighbourhood of Windscale.

Iodine-131 emits both beta- and gamma-rays. As gamma-radiation can penetrate considerable thicknesses of matter it is possible to demonstrate the uptake of radio-iodine by the thyroid gland of a man or animal simply by placing a suitable counter close to the thyroid; that is to say just above the larynx in the neck. This technique has been used recently to investigate the effect of certain chemicals on the action of the thyroid.

Thyroid-blocking agents. Salts of thiocyanic acid (HCNS) produce clinical effects in animals suggesting a reduction in thyroid activity. Thiocyanate is of practical agricultural interest because it can be derived from compounds of prussic acid called *glucosides* which occur in certain plants. The conversion of prussic acid (HCN) to thiocyanic acid (HCNS) is in fact a detoxication process which serves to protect grazing animals from what might otherwise be dangerous doses of prussic acid.

In a recent experiment carried out in New Zealand three groups of rats were injected with potassium iodide, in which the iodine was radioactive. About an hour later thiocyanate was injected into each animal of two of the groups (two different dose levels being used) and the third group left as a control. The animals were kept under light anæsthesia and the radioactivity of their thyroid glands was then measured over a period of five hours. Figure 1 shows the course of incorporation of labelled iodide into the animals' thyroid glands. Most was taken up by the thyroids of the animals which had received no thiocyanate (top curve), whereas the thyroids of the thiocyanate-treated animals took up appreciably less, depending on the dose of thiocyanate they had received.

This convincingly demonstrates the

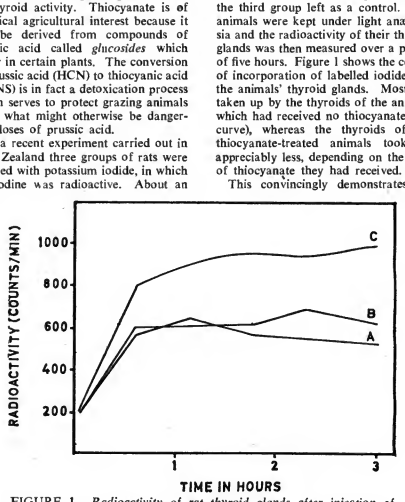


FIGURE 1. *Radioactivity of rat thyroid glands after injection of potassium thiocyanate and then KI^{131} 0.86 hours later. Curve A, rats which received 17.5 mg thiocyanate. Curve B, rats which received 12.5 mg thiocyanate. Curve C, control rats which received no thiocyanate. (After Flux et. al. N.Z. J. Sci. Tech. 38, 88, 1956.)*

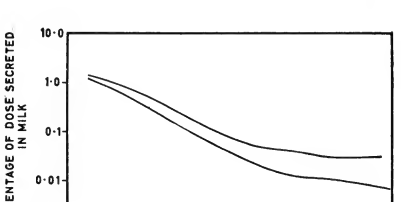


FIGURE 2. *Secretion of radioactivity in milk of dairy cow after an oral dose of radioactive potassium iodide (KI^{131}). Top curve, activity corrected for decay. Lower curve, observed activity. (From R. F. Glascock. J. Dairy Research.* 21, *318, 1954.)*

thyroid-blocking effect of thiocyanate, but as in all research the expected does not always follow: when animals were fed on plants known to contain glucosides the reverse of the expected effect was observed and their thyroids took up more radioactive iodide than the controls. The cause of this anomaly will no doubt be found as the work continues.

Transmission of iodine from food to milk. The metabolism of iodine is also interesting because of its chemical similarity to chlorine, of which large quantities are taken in by animals in the form of sodium chloride. The chloride content of cows' blood is constant at about 5 grams per litre of blood, whereas it is only about one-third of this in milk. Most of the chloride taken in with the food is excreted in the urine to the extent of about 120 grams per day.

In a recent experiment which I conducted a minute dose (50 micrograms) of radioactive iodine in the form of potassium iodide was given to a lactating cow by mouth. The radioactivity of the milk was measured each time the cow was milked and was plotted against time as shown on the graph in Figure 2. The upper curve has been corrected to allow for the continual decay of the iodine-131. It shows the concentration of labelled iodide which would have been observed if the isotope had not decayed. The maximum concentration was reached in the second milking of the first day.

It appears that the first thing that happened to the iodide was that it mixed uniformly with all the water of the animal's body, including the milk. This state of affairs did not last long, the downward slope of the curve indicating that fairly rapid excretion was occurring.

The graph, it should be noted, is *semilogarithmic*, that is to say, equal intervals along the vertical axis represent equal powers of ten (10, 100, 1000, etc.). The part of the graph lying between 2 and 9 days is virtually a straight line, which on this type of graph means that the concentration of iodide in the milk diminished by a constant fraction each day. It can be deduced that it declined to half every 1.5 days. By the end of 9 days the concentration in the milk was only one-twentyfifth of what it had been at the maximum value.

The concentration in the urine was also measured from time to time and found to be always much higher than in the milk. For example, on the eighth day it was ten times as high, indicating that, like chloride, much more iodide is excreted in urine than in milk.

The lower curve of the two shown in Figure 2 is that of actually observed radioactivity and is the one to be considered when estimating radiation hazards. The actual radioactivity declines to half every 1.2 days, from which it follows that it would have diminished one thousandfold after about 12 days. It can also be deduced from the curve that a total of only 3½ per cent. of the activity taken in by the cow in the form of a single dose actually appeared in the milk and that, if the same dose were repeated over many days, the concentration in the milk would become constant at 2.3 times the maximum resulting from a single dose. As soon as the intake of radioactive iodine ceases, of course, the radioactivity in the milk would again decline with a half-period of 1.2 days.

Studies on Vitamin B_{12}. It has been known for many years that pernicious anæmia is due to the lack of one of two essential substances. These have been called the *intrinsic factor*, which is present in the gastric juice, and the *extrinsic factor*, which is present in the food. In 1948 Rickes and his colleague in America isolated the extrinsic factor in crystalline form from liver and called it vitamin B_{12}. It contains an atom of cobalt in its molecule. The intrinsic factor is known to be a mucoprotein secreted with the gastric juice.

Labelled vitamin B_{12} can be prepared by growing certain micro-organisms in a medium containing one of the several radioactive cobalt isotopes. In some recent work by Holdsworth and Coates on the way in which intrinsic and extrinsic factors interact, vitamin B_{12}, labelled with cobalt-57 (half-life 270 days) was used.

Very small quantities (about 6 one hundred-millionths of a gram) of the labelled B_{12} mixed with different types of intrinsic factor were introduced into isolated portions of the intestine of separate rats. After 20 hours each rat was killed and, with the exception of the segment of intestine, the whole of its carcase tested for radioactivity.

The results showed that intrinsic factor from the *same species*, in this experiment another rat, increased the absorption of B_{12} from the intestine, but that intrinsic factor from a different species (pig) actually hindered it. Not all animals are so particular about the source of their intrinsic factor however; other experiments have shown that both pig and rat intrinsic factor promote B_{12} absorption in man.

The origin of milk fat. In 1936, long before isotopes were available for biological research, Graham, Jones and Kay demonstrated that during the passage of blood through the cow's udder there was a decrease in the concentration of some of its constituents but not in others. Of the fatty compounds circulating in blood the concentration of neutral fat (tri-glycerides) decreased,

RADIO-ISOTOPES AS AN AID TO THE ANIMAL PHYSIOLOGIST *continued*

whereas that of phospholipids did not. It was concluded that the neutral fat of the blood must be the chief precursor of milk fat.

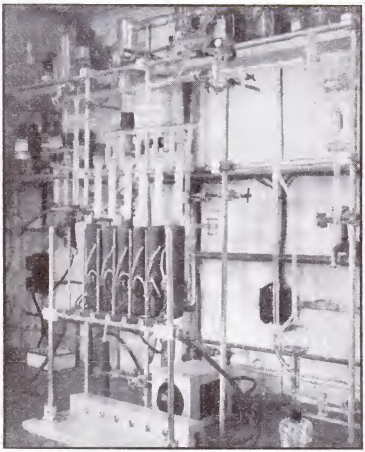
By 1951 radioactive carbon-14 (half-life more than 2000 years) had become generally available for research purposes and an experiment was carried out by Folley and his colleagues in which the sodium salt of acetic acid labelled in the carboxyl carbon atom with carbon-14, thus, $CH_3C^{14}OOH$, was injected into a lactating goat. The goat was milked at intervals and the carbon dioxide it breathed out collected by absorption in an alkali. By measuring the total radio-activity of breath carbon dioxide it was concluded that the goat completely oxidised and expired 80 per cent. of the administered sodium acetate. Of the remaining 20 per cent. half appeared in the milk in the form of radioactive fat.

Fat is a compound of glycerol (glycerine) with fatty acids. When the fatty acids of the goat's milk were split off from the glycerol and separated into groups according to molecular size, it was found that the very short chain acids such as butyric (4 carbon atoms, or C_4), caprylic (C_8) and caproic (C_6) contained most radioactivity, whereas those containing 16 or 18 carbon atoms per molecule contained least. By degrading the caproic acid (6 carbon atoms) carbon atom by carbon atom, it was found that alternate carbon atoms were radioactive. (See Figure 3) This is what would be expected if, intermediate reactions being neglected, the caproic acid had been formed by the stepwise addition head to tail of acetic acid molecules one to another.

The earlier work on blood analysis thus gave conflicting results: the one implied that milk fat is carried ready-made to the udder by the blood and the other that it is synthesised in the udder itself from acetic acid. One might guess that the truth would lie somewhere in between; that, perhaps, the long chain fatty acids are derived from blood and the short chain acids from acetate.

Further work has been done recently by my colleagues and myself, and is still in progress, to find out how much of the milk fat is derived from sources other than acetate. In one experiment we fed a goat on fat labelled with radio-active hydrogen (tritium) and studied the secretion of radioactive fat in its milk. The concentration of radioactivity in the milk fat reached a maximum 23 hours after the dose had been given, and then declined smoothly in a way somewhat similar to that of radioactive iodide, as shown Figure 2. From the total amount of fat in the food that the goat had eaten during the experiment, the total amount of fat secreted into the milk and the fraction of the dose of radio-activity in the milk, it was possible to calculate the proportion of the milk fat that had been derived from dietary fat. It worked out to be 24 per cent.

This does not mean that the remaining 76 per cent. of the milk fat must have come from acetate, though much of it might have done. It might well have been derived from carbohydrate converted into fat by the liver and transported to the udder in the blood. Further work is in progress to measure the contribution of blood fat to milk fat. Virtually, the only way of attempting this problem is by the continued use of isotopically labelled compounds.



Apparatus for measuring radioactive hydrogen by gas counting.

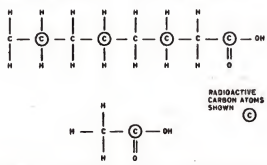


FIGURE 3. *Molecular chain of (top) caproic acid in goat's milk and (bottom) acetic acid injected in goat as sodium acetate.*

IT SEEMS TO ME

by GEMINUS

THE inventors of Winnipeg are an imaginative crowd. Their annual exhibition held last week seems to have produced some new ideas that cannot possibly have been thought of before—and which I find it hard to understand.

One of the gentlemen has, for example, devised a way which he claims can shrink a human body to the size of a baby. He claims that his invention will be an excellent way of disposing of dead bodies because it would be possible for the shrunken corpses to be slid into underground tubes and buried there without any of the fuss that goes with conventional burial and without taking up much space.

His shrinking process apparently depends on the application of high pressure to a corpse. This, he says, has the effect of squeezing all the fluids out of a body and the resultant mass of flesh is compressed to any desired shape in a mould like those used for moulding polythene.

All this is highly ingenious, but I cannot see why the inventor thinks that his form of burial is in any way better than cremation—which is not burial, of course. It may be that his method would appeal to those who are worried both by the high cost of renting plots in cemeteries and at the same time by the possibility that some kind of physical reincarnation is likely to happen to them.

Anyway, it appears that the inventor has not yet found a volunteer for his process. Neither has another of the inventors at the show been able to make much headway with his invention. This consists of a gigantic cake of soap 15 ft. long and 3 ft. across. The idea is that you sit on the soap and slide up and down to wash yourself.

★

ALL the geography books in elementary schools have a great deal to say about the way in which large towns have grown up at river crossings. If one is to take them seriously one has to believe that there is some great advantage in siting towns in such a way, but whatever the Romans may have got out of such a policy, I think there is no doubt that the time has long passed when a river running down the middle of a town was anything but an intolerable nuisance.

One morning last week I was rash enough to try and travel from my house, which is just south of the Thames, to my office on the north at the peak morning hour. It took just twenty minutes to travel a mile up to the bridge head which I normally use. For the whole of that time I travelled in jerks of about twenty yards, and three lanes of traffic jammed together for the whole distance did just the same.

Oddly enough, the bridge itself was entirely clear of traffic jams, and once on it I took no more than a few seconds to cross the river; but on either side the approach roads were jammed for several hundreds of yards.

Part of the trouble was that the several policemen on duty were waving their arms about like semaphores in the fond belief that they were helping people, while they seemed entirely to ignore half a dozen lorries and private cars parked in places where the traffic was thickest. This kind of area, I would have thought, ought to be one in which parking is entirely prohibited and in which the police pay to some trouble to enforce regulations.

But parking cannot explain all the delay, which I am told occurs nearly every weekday morning. The real trouble is that so many roads converge on to each end of the bridge at more or less the same point. It is like trying to pour cars down a funnel. No doubt the Romans were wiser than we were and did not attempt the same exercise with chariots. But since we seem fated to have more cars on the roads in the near future, there is surely a strong case for prohibiting the building of any new towns on the banks of rivers—and even for filling in some of the rivers which at present bisect our larger towns.

★

THERE is a certain logic in the proposal of an American Congressional committee that 20,000 million dollars should be spent in the United States on the building of deep air-raid shelters. For if a nuclear war comes it is obviously quite possible that some people will escape entirely the immediate effects of the bombs—blast, heat and gamma radiation—and that they will only be exposed to the slower effects of fallout. So if shelters suitably air-conditioned and sufficiently far below ground are available, it would be possible to protect some percentage of any population from radiation sickness. Thus, any country sufficiently rich could be comforted with the thought that whatever happened to the main fabric of its society, a few of its people would live to see another world.

But 20,000 million dollars is a lot of money, even by American standards. And deep air-raid shelters of the kind the committee is considering have to be elaborate affairs in which people could live without too much discomfort for several months. So I think it is inevitable that if these shelters are built in the United States people will start asking themselves: "Why don't we go and live there now, instead of waiting for the bombs to fall?"

And of course there is no reason why they should not move underground. Housing space is hard to get in the big American cities.

It will be recognised that this step is but the thin end of a very unpleasant wedge. As soon as some Americans move underground the others will start asking why they, too, cannot benefit from such good protection. Then there will be more air raid shelters and still more people will be living underground. Eventually, of course, the whole of America's population will disappear from the surface, by which time it will seem only logical to put factories and industries underground, too. But people living in this strange way will soon recognise that their lives depend on food supply and that agriculture in the sense we know it will be vulnerable to atomic attack.

It is at this point that they will start cultivating algae and fungi in artificial forms underground, and it will then be possible for them to forget about the rest of the world.

There are only two comments I want to make on this horrific picture. First, it will be recognised that lots of science fiction writers have tried to chill our blood in this way but until now we have been able to scoff at them. So the American proposal is the first sign that things might really go this way.

My second point is that the Americans appear to have conceived this notion out of a panic which concerns itself more with immediate questions of survival than with the broader issues. It seems to be born of a conviction that the cold war will continue indefinitely unless it is finished by a nuclear disaster, and at the same time, that there would be some point in bequeathing to the post-war world a sample of the kind of society in which we now live.

BOOKS

The history of chemistry

by Dr. TREVOR I. WILLIAMS

THROUGH ALCHEMY TO CHEMISTRY. By John Read. (G. Bell & Sons, Ltd. 206 pp. 18*s*. 6*d*.)

WHILE the need for integration of humane and scientific studies is widely accepted in theory, there is much controversy about how it may be achieved in practice. The study of the history of science is, however, generally agreed to be one useful method of approach and this new book by Professor Read is a striking example of how successful it can be. With almost no recourse to formulae and equations he shows, in a book notable for literary quality as well as for scholarship, how modern chemistry has grown out of the mystical practices of the alchemists. A large number of illustrations, mainly from original sources, greatly add to the interest of the text.

This book is inspired by two great figures of the past whom it is at first surprising to find linked together at all. The first is the poet John Donne, who believed that for a mystery to have universal significance it must be made comprehensible to ordinary mortals. The second is the physicist James Clerk Maxwell who wrote: "In Science, it is when we take some interest in the great Discoverers and their lives that it becomes endurable, and only when we begin to trace the development of ideas that it becomes fascinating." On their dicta Professor Read bases a history of chemistry up to the end of the nineteenth century which is notable for its clarity and for the way in which the principal personalities described are brought to life.

Alchemists are still too often thought of as crude practitioners, seeking the elixir of life and the transmutation of metals by blundering empiricism. While this description might be applied to the uninstructed "puffers"—such as those at whom Chaucer pokes fun in the Canon's Yeoman's Tale—the best of the alchemists were men highly cultured by the standards of their day. To say that they were ignorant of many principles fundamental to modern science, that their inquiries were richly interwoven with mysticism, that their writings were deliberately expressed in an esoteric form very difficult for any but the adept to comprehend, is to say no more than that they were characteristic of their age.

In spite of these limitations they gradually built up a body of sound chemical knowledge from which can be directly traced the development of modern chemistry. This development was sometimes evolutionary, in the sense that it depended upon the steady accumulation of fruitful knowledge, sometimes revolutionary—as in the second half of the eighteenth century—when the inspiration of such geniuses as Black, Priestley, and Lavoisier enabled whole fields of chemistry to be interpreted in terms of simple principles. Professor Read's new book can be strongly recommended to the layman as an introduction to chemistry and to the general chemist as an excellent review of the history of his subject. Although the serious historian of science will find very little new here, the book deserves his attention as a refreshing and orderly review of the essentials of the subject.

Conduction in gases

ELECTRICAL DISCHARGES IN GASES. By F. M. Penning. (Philips Technical Library. Cleaver-Hume Press. Pp. viii+78, 15*s*.)

THE study of gaseous discharges must surely be one of the senior current fields of physical study. Its modern history dates from the work of the early pioneers of the middle and late 19th century, amongst whom Faraday, Plücker, Crookes and J. J. Thomson were notable. The advent of the quantum theory in the early 1900s and the subsequent rapid growth in experimental work on simple atomic collision processes (to which the German workers Franck and Hertz made major pioneering contributions) paved the way for a detailed quantitative approach to the macroscopic phenomena of electrical conduction in gases.

The late Sir John Townsend's remarkable and brilliant work (about 1912 onwards for some 30 years) provided the lasting foundation for the later efforts

BOOKS *continued*

of many investigators in the subject. It is a humbling and also inspiring experience to read Townsend's papers of this period, and to compare his experimental facilities with the modern (necessary) clutter of complicated electronic equipment familiar to present laboratory workers.

Following Townsend there have been, and are still, many eminent theoretical and experimental scientists and engineers who have studied gaseous discharges. It is not invidious to place Penning's name amongst the greatest of them. In particular his brilliant studies of electrical breakdown in the rare gases at low pressures should be mentioned. The present work is a fairly brief, elementary but very clearly written general account of electrical gaseous conduction, in which, naturally, emphasis is given to breakdown studies, although maintained discharges are not neglected. It can be recommended particularly for physics students and for engineers, because some of the vast practical applications are touched upon.

It is unfortunate that Penning did not live to share in the most exciting of modern discharge activities—the attempt to produce thermonuclear reactions in hot discharges, still in its earliest and most stimulating stage. He would have had much to contribute.

J. D. CRAGGS.

Our cultural development

MAN'S JOURNEY THROUGH TIME. By L. S. Palmer. (Hutchinson. 30s.)

DR. PALMER, who was until recently Professor of Physics at Hull, and is now Honorary Curator of the Wells Museum in Somerset, has written what he calls "a first step in physical and cultural anthropochronology," and what his publishers call "a first step in the new subject of anthropochronology." We open his book, therefore, with great interest, but find that at first sight this new subject is not so new; that it differs very little from what is generally called geochronology.

Dr. Palmer gives us an account of those techniques of dating used by the geologist and archæologist and usually referred to as geochronology, which have already been set out in Zeuner's *Dating the Past*. He does this clearly and accurately and provides us with a valuable account of the fluorine, carbon-14, clay-varve and other techniques used by the geochronologist.

What is new in Palmer's analysis is his treatment of man's cultural development. He has sought after some way of obtaining a graphical or quantitative pictorial representation of man's cultural development, and suggests that three criteria of culture could be assessed numerically and would, therefore, be suitable for the ordinates of a cultural development/time graph—time being the abscissæ. The three criteria used are, first the number of different materials used by man, secondly the number of different occupations with which man is engaged, and thirdly the speed at which man can move by mechanical means. He pursues these three criteria and provides us eventually with a Cultural/Development time graph (Figure 55) showing the development of Australian aborigines, Egypt, and England.

All this seems very learned, and Professor Palmer has done an immense amount of work, but in the end it seems to get us no further forward than we were before. He has taken a very large steam-roller to crack a small nut. The basic facts about the physical and cultural development of man are well known and are set out for the general public in numerous available books from Le Gros Clark's *History of the Primates* to Gordon Childe's *What Happened in History* and Carleton Coon's *History of Man*.

Palmer has taken these facts and restated them with a wealth of graphs and formulæ which, while making them more difficult to understand, do not add to their significance in any way. The publishers claim that in the last chapter some consideration is given to the probable trend of man's journey into the atomic age; all I can find in summary of this consideration is the statement that "whether the gradients of the graphs of physical and cultural development indicate a progressive or a retrogressive state of human evolution depends entirely on man's present and future behaviour; it is for the present and the next generations to ensure that the gradients do mean Progress." This seems an unexciting and unoriginal thought with which to conclude a long, learned and rather laborious work.

GLYN DANIEL.

Other books received

FERRO-ELECTRICITY IN CRYSTALS. By Helen D. Megaw. (Methuen & Co., 27s. 6d.)

THE CHEMISTRY OF THE STEROIDS. By W. Klyne. (Methuen, 18s.)

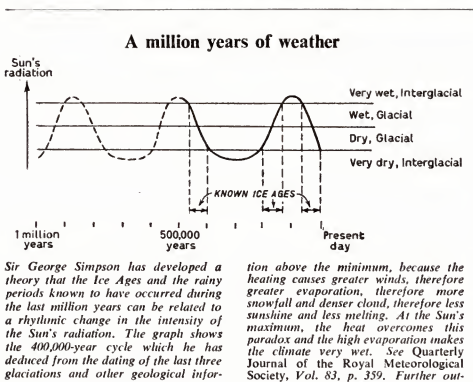
ANALYTICAL CONICS. By Barry Spain. (Pergamon Press. 30s.)

A STUDENTS' HANDBOOK OF ORGANIC QUALITATIVE ANALYSIS. By J. B. Bowen, S. H. Graham, A. J. S. Williams. (University of London Press. 15s.)

PROCESS ENGINEERING IN THE FOOD INDUSTRIES. By R. J. Clarke, M.A. (Heywood and Co., Ltd., 60s.)

TRENDS AND DISCOVERIES

A million years of weather



Sir George Simpson has developed a theory that the Ice Ages and the rainy periods known to have occurred during the last million years can be related to a rhythmic change in the intensity of the Sun's radiation. The graph shows the 400,000-year cycle which he has deduced from the dating of the last three glaciations and other geological information. Paradoxically, Ice Ages are caused by an increase in the Sun's radiation above the minimum, because the heating causes greater winds, therefore greater evaporation, therefore more snowfall and denser clond, therefore less sunshine and less melting. At the Sun's maximum, the heat overcomes this paradox and the high evaporation makes the climate very wet. See Quarterly Journal of the Royal Meteorological Society, *Vol. 83, p. 359. Further outlook for the next 200,000 years: very dry, little ice.*

The camel's hump

THE camel has a physiological mechanism, as yet unexplained, which ensures that water is lost from the tissues only and the blood does not become dry and viscous as a man's does after exposure to hot, dry air. Thus the camel escapes "explosive heat death" which occurs in a man when the blood is too sluggish to convey heat to the skin.

This was one of Prof. E. B. Edney's points in his inaugural lecture at the University College of Rhodesia and Nyasaland, on survival in hot deserts in terms of evolution. The lecture has been published by the Oxford University Press.

The old fallacy that the camel's hump is a water tank has been replaced by a new one, that the fat of the hump is oxidised to make water. In fact, it is simply a food store. The reason why so much fat should be humped together is that if it were distributed over the body it would form an insulating layer impeding cooling.

The camel can tolerate a loss of water equal to nearly a quarter of its body weight—twice as much as a man can—and replace it in a few minutes' drinking. Moreover it can tolerate a rise in body temperature from 34 degrees C. at night to 41 degrees by day, before sweating becomes necessary.

The insects, spiders and crustacea which also inhabit the deserts have not evolved to cope with true desert conditions. They escape the Sun in burrows or under stones.

Cod rhythms

IN Oslo, P. Stockleth Enger has used electrical pick-ups in the head and the usual techniques of electroencephalography to record the brain rhythms of the codfish. This was probably the first experiment of this sort on a fish.

He was led into this investigation by fears expressed by fishermen that acoustic echo sounders used for detecting shoals of fish might in fact scare the fish away.

Enger found important similarities with the rhythms in men and mammals. Arousal by light was accompanied by the characteristic quickening of the principal rhythm, as happens in man. However, no arousal reaction was produced by acoustic stimulation.

He describes his findings in *Acta Physiologica Scandinavica*, Vol. 39, p. 55.

Solar shock waves

WHEN an explosion occurs on the Sun's surface a burst of radio noise can be observed on the Earth, with the curious property that the wave-length of the radio signals increases progressively as the minutes pass. It is like the effect of a pianist running his fingers down the keyboard. Because it is known that successive layers of the Sun's atmosphere (corona) emit radio waves of increasing wavelength it has been generally agreed that a stream of particles shot out of the Sun triggers off each layer into radio activity as it passes through.

Now, K. C. Westfold, of Sydney, has argued in the *Philosoplical Magazine* (Vol. 2, p. 1287) that it is not the particles themselves that cause the radio emission, but the acoustical shock waves that travel ahead of the stream. To explain how a shock wave can travel at speeds of about 100,000 km/sec. (as is deduced in some bursts by the rate of change of radio wave length), Westfold invokes the powerful magnetic fields which prevail on the disturbed Sun to deduce a comparable velocity of sound.

UNESCO maps illiteracy

IN 1950, 44 per cent. of the world's population over 15 years of age could not read and write. This is the conclusion of the first attempt to present estimates on the extent of illiteracy in every country and territory of the world.

After Europe and North America, the highest literacy rates were in the small islands of the South Pacific. Africa has the lowest literacy rate, and in Asia alone there were 510 million illiterates. See *World Illiteracy at Mid-Century* published (at 10s.) by the United Nations Educational, Scientific and Cultural Organisation.

FAO maps grass

THE Food and Agriculture Organisation of the UN has prepared the first map of the grass cover of the greater part of the African continent.

Combined with data on climate and soils, the information which J. M. Rattray and R. O. Whyte have collected for the FAO map will make possible plans for improving the grasslands or ploughing them for cultivation. This is part of a scheme for mapping grass in several regions of which no such map is at present available: the next region to be studied is Latin America.

LETTERS

The Bragg equation

Sir,—I read with much interest Sir Lawrence Bragg's beautifully illustrated article on "X-ray analysis" (21 November).

But I am sorry to mention that your readers have missed the most important chapter of the history of X-ray analysis, obviously due to the modesty of the brilliant author. Today one could hardly write the history of "X-ray analysis" without mentioning the Bragg equation (named after the discoverer, Sir Lawrence Bragg) which is the foundation of X-ray analysis. In actual fact, the son (Sir Lawrence) shared the Nobel Prize with his father Sir William for the outstanding contributions to this branch of physics.

It is exciting to read about Sir Lawrence's own experience: "...The problem then remained to explain why only certain spots appeared in the Lane photographs, and I ascribed this to the fact that the essential underlying lattice of the crystal was face-centred and not simple cubic. I communicated these results to the Cambridge Philosophical Society in November 1912." The "Bragg equation" appeared in this paper (p. 46) in the form $\lambda = 2d \cos \theta$, but in later papers θ was defined as the glancing angle and not the angle of incidence.

S. K. GUHA.

Gower Street,
London, W.C.1.

The brain

Sir,—As an anatomist I find it impossible to conceive of any system made up of living substance which is not primarily an energy system. The act of living itself implies energy changes, and a dead brain does not work, no transfer or handling of data, no storage of facts or fantasies, and no abstractions. I cannot agree with Doctors Gregory and Campbell (*Letters*, 21 November) that cybernetics is a new concept. To me, it is the application of a new analytical technique which has yielded its own particularly interesting results. Perhaps in dealing with the central nervous system we will require to have our own brand of biological complimentarity to enable us to equate body and mind.

G. M. WYBURN.

University of Glasgow,
Glasgow, W.2..

Leaf proteins

Sir,—Dr. Pettersson has perhaps overstated the case he makes for *initiating* research on the extraction of food protein from green leaves, by implying that the idea is relatively novel, and that little is known about the process. (*The Biological Productivity of Great Britain*, 7 November.)

In fact, as early as 1937, Dr. R. E. Slade, addressing the British Association in Nottingham, suggested that mechanical treatment of leaves would yield a valuable new source of protein for human feeding. Patents were taken out by Dr. Slade with ICI Ltd., covering the process (British Patents No. 511,525 (1939), and No. 573,721 (1945).

Again, in 1942, Mr. N. W. Pirie advocated the extraction of leaf proteins as an additional source of home-produced protein in wartime, and his present work at Rothamsted (reported by Dr. Pettersson) is a later development of this. At least twenty different groups of workers, both in this country and overseas, are known to have worked on this problem, and to have published or patented their findings. A number of large-scale machines have been produced which will extract juice containing up to two-thirds of the crude protein (not *protein*) from a wide range of leafy crops. However, only part of the crude protein in this juice is coagulable, and, in all reported work with large-scale extractions, less than half of the crude protein of a crop has been recovered in the dried coagulum which is prepared as "leaf protein." This coagulum is certainly not "mainly rich protein" or "all food," as it generally contains less than 50 per cent. of crude protein on a dry matter basis, much of the remaining material being silica and other ash, chlorophyll, waxes, etc., and of little nutritive value.

Investigations have tended to concentrate on the problems of the extraction of protein from leaves, and it has been assumed or stated that the products would be "first class" proteins, comparable with those of meat and other animal products. The nutritional evidence suggests, however, that leaf proteins, as at present prepared, are equivalent in protein value only to the oil seed meals, to which at the same time they are markedly inferior in energy value. This relatively low protein value appears to be due mainly to a deficiency of "available" lysine in leaf proteins, but it is not known whether this simply reflects a deficiency in the original plant, or results in part from damage during the extraction process.

The conclusion must, therefore, be made that engineering studies with large-scale machines are at the moment less important than the biochemical study of the nitrogen fractions in leaves, combined with nutritional studies with laboratory animals. From such experiments, together with considerations of the economics of the process, it should be possible to decide at which stage, if any, the development of pilot scale machinery is justified. It is a salutary thought that the first results on feeding experiments were not published until 1953, 14 years after Slade and Birkinshaw patented the production of "grass cheese."

An account of studies carried out at this Institute, on which some of these conclusions are based, has recently appeared in *Colonial Plant and Animal Products*, Vol VI, No. 1, pp. 3-19 (HMSO, 1957) and a review article is to appear in *Herbage Abstracts* in December.

W. F. RAYMOND.
J. M. A. TILLEY.
The Grassland Research Institute,
Hurley,
Berkshire.

Apprentice training

Sir,—Professor Williams has written a most controversial article on apprentice training which, to the layman, has made interesting reading. There is clear evidence when reading between the lines that the writer has not got her information from the shop floor.

It must be agreed that present-day apprentices do pick up a large amount of their skill from craftsmen. The writer must not lose sight of the fact that training today is very much more intensive and most factories of repute have specially built basic training shops, with highly-skilled tradesmen as instructors; these men are specially selected for the necessary examples that have to be set. It would be a sorry thing if apprentices were so bogged down with their work that they were not permitted to perform duties, no matter how menial the task; boys should be taught obedience, willingness and graciousness. Many firms are providing such opportunities for allowing boys to develop these worthwhile characteristics.

Lady Williams appears to have had contact with certain Technical Colleges that are unfortunate in having low-

LETTERS *continued*

quality day-release students. Most firms today have rigid minimum standards before they will accept a school-leaver for apprentice training. If the writer had made a more broad survey for her information, she would have ascertained that "repeated failures" at Technical Colleges are considered on their merits by sponsoring firms. Is the writer aware that most large works or factories have representation on the advisory panels of these colleges?

There is little evidence available to support the theory that training schemes are failing to produce the "type" of craftsmen required; in a few trades the "number" trained is below the nation's demand.

There may be one or two so-called skilled trades where the length of training could be advantageously curtailed. The writer must accept the fact that it is not always the type of trade that demands a certain period of training, it is invariably the individual. Firms today have such flexible schemes that no bright boy is held back in order to conform to mediaeval traditions. The bright boy is given the opportunity for having an insight into administration, design and tasks that call for acceptance of responsibility during the last year or so of a 5-year apprenticeship.

Should Lady Williams think fit to embark further on the subject of apprentice training, she would be well advised to review her observations from experience on the shop floor.

H. M. NEWBERY.

Connah's Quay,
Chester.

The S.M.A. and "General Science"

Sir,—Mr. W. G. Rhodes, Chairman of the Science Masters' Association, seems to suggest in his letter (14 November) that the "declared policy" of the association is in favour of General Science and against the separate subjects. Although I have been a member for many years, I am not aware of any such "declared policy" on this controversial topic; neither, apparently, is Dr. H. F. Boulind, lately secretary of the association and still a member of its committee. May I quote from a letter of his in the *Times Educational Supplement* of 18 May 1956, rebuking a correspondent who had urged the association to revise its policy of support for General Science:

"As a recent secretary of the association, I really must protest against this implication: the association has never chosen a 'policy of support for General Science' in preference to separate subjects."

W. S. JAMES.

Education Department,
University of Bristol.

Re-electrifying the Merchant Marine

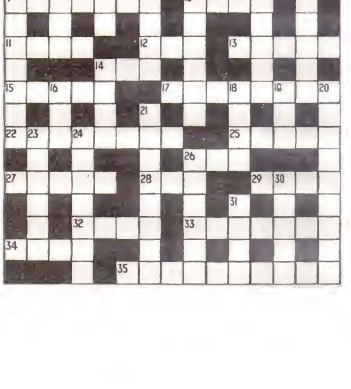
Sir,—Condensing of the opening paragraph of my article (*Re-electrifying the Merchant Marine*, 21 November) has led to the introduction of a more critical note than was intended. It has also led to the implication that oil tankers have electric deck machinery, and I would be grateful for space to correct this.

For reasons of safety, oil tankers use steam-driven auxiliaries on deck. It was because the change of alternating current could be made in these ships without involving problems of winch control that tanker operators led the way in the adoption of a.c electrical installations.

IAN BREMNER.

The Shipping World.

Crossword No. 55



ACROSS

1. Perhaps use a prop to reach it, about 6 miles up (10).
7. Fibre not for a woman member? (4).
9. The girl will call back for the record material (7).
10. Rail crash in Italy! (4).
11. That's the way! (4).
12. It's none of my business if you do it! (3).
13. Therefore, the cover has a definite shape (5).
14. Shows how objective she can be (3).
15. Where to find the super and the coppers, too (5).
17. A dog, like a pig, can fly in S. America! (8).
22. Abandoned birds of prey intent on raw materials (8).
25. Finally go slow movement (5).
26. Might make a cricketer! (3).
27 and 34. Should a red card win, your hand many feet it (9).
28. That bird's cooked! (3).
29. If you fight with it nowadays, it's pointless, so to speak (4).
32. Can I bring the family round? (4).
33. Seems you may retain the ore (7).
34. See "27."
35. Flying-officer from Russia? (3, 7).

DOWN

1. Litmus, for example? (9).
2. Open too much tea, it seems (5).
3. Hooters! (4).
4. It's only weighed coming up (6).
5. In this element, you might find emus around the Nile (8).
6. Shiner, the beast! (7).
8. Sheep found in Rome? (6).
14. He has nothing on a woman for bravery! (4).
16. Dead letters! (3).
18. A friend who fights with you! (4).
19. That's no way to speak to a lady! (3).
20. Apparently, you wouldn't eat it as part of breakfast! (9).
21. Would you find a pilot-fish in it? (8).
23. Not liking a piece of poetry (6).
24. Insect and for a period it is tailless (7).
26. Amused, perhaps, by a jellyfish (6).
30. Going before the superior (5).
31. Be a husband? (4).

SOLUTION TO CROSSWORD NO. 54

ACROSS:—
1. Razor-fish. 6. Baird (bared). 9. Able. 10. Rack. 11. Side-S. 12. Planes. 13. Open. 15. Too (two). 16. Near. 18. Perchloe. 22. Bell metal. 24. Halo(gen). 26. Bat. 28. Seed. 29 Extent. 31. Ounce. 32. Star. 33. Nail. 34. Steel (steal). 35. Aristotle.

DOWN:—
2. Ambulance. 3. Ocean. 4. F-ores-t. 5. Suc-Rose. 6. Bi-son. 7. Is-let. 8. Dispose. 14. Exit. 17. All. 19. Lea. 20. Spoon-bill. 21. W-ere. 22. Ba-boo-as. 23. Auditor. 25. Beards. 27. Tense. 28. Swell. 30. Tan-go.

CONTRIBUTORS

CHARLES FREDERICK CARTER (*How Britain can get more scientists*), who is thirty-eight, has been Professor of Applied Economics at The Queen's University, Belfast, since 1952. Formerly he lectured in statistics in the University of Cambridge, and was a Fellow of Emmanuel College.

Professor Carter was chairman of the Science and Industry Committee set up by the British Association for the Advancement of Science, the Royal Society of Arts, and the Nuffield Foundation in 1954. He was a member of the United Nations committee on commodity trade, and has been joint editor of the *Journal of Industrial Economics*. He is the co-author of five books, the most recent of which was *Industry and Technical Progress*. He is married, with three children, and "likes trains." (*pages* 14, 15)

PETER THOMAS HASKELL (*Flight instrumentation in insects*) is Senior Scientific Officer in charge of physiological research at the Anti-Locust Research Centre of the Colonial Office. He was educated at Portsmouth Grammar School and the Imperial College of Science and Technology. Between 1951 and 1955 he was lecturer in entomology in the Zoology Department of that College.

In his present work the emphasis is on sensory physiology and its relation to behaviour in insects. Hearing and stridulation of insects, particularly grasshoppers, are aspects of this field in which he takes a special interest. Dr. Haskell is on the council of the Association for the Study of Animal Behaviour. His home is in Berkshire. As the owner of a large country garden he is forced, he says, to spend much of his spare time improving on Nature. (*pages* 16-18)

BRIAN GILMORE MAEGRAITH (*The Chinese are "liquidating" their disease problem*) is Professor and Dean of the Liverpool School of Tropical Medicine. He is an Australian, and came to this country as a Rhodes Scholar after taking an M B at Adelaide University. During the thirties he held various research fellowships, then became lecturer in pathology and Dean of the Faculty of Medicine at Oxford.

Professor Maegraith was appointed to the Chair of Tropical Medicine at Liverpool University in 1944. He is a member of the Colonial Medical Research Committee, the Sub-committee on Malaria, and the Chemotherapy Committee of the Medical Research Council. Last year he was Visiting Professor in the University of Alexandria. He is fifty. (*pages* 19-21)

HELEN KEMP PORTER (*How plants grow: a study made possible by carbon-14*), a Fellow of the Royal Society, began her career as research assistant in the Department of Plant Physiology of the Imperial College of Science and Technology. Later she joined the staff of the College's Research Institute of Plant Physiology, where she is now Principal Scientific Officer. Dr. Porter is also Reader in Enzymology in the University of London. Much of her work has been concerned with the biochemistry and physiology of starch, and transformations of radioactive sugars by plant tissue. Dr. Porter, who is the widow of Dr. William G. Porter, lives in Paddington. Her hobby is needlework. (*pages* 27-29)

ROBERT SCOTT RUSSELL (*Plant nutrition study with radioactive tracers*) directs the Radiobiological Laboratory of the Agricultural Research Council. He was formerly employed by the Rubber Research Institute of Malaya as plant physiologist and, more recently, has been a demonstrator in the University of Oxford.

Dr. Scott Russell, who is forty-four, is married and has three children. He is a keen climber and has written a book called *Mountain Prospect*. (*pages* 31-33)

RAYMOND FREDERICK GLASCOCK (*Radio-isotopes as an aid to the animal physiologist*) heads the Isotope Section in the National Institute for Research in Dairying at Reading University. As a biochemist, he has been particularly interested in problems such as the fat metabolism of farm animals and lactation. He has published two books: *Labelled Atoms* and *Isotopic Analysis for Biochemists*.

During the war he was attached to the Inter-Services Research Bureau, then spent three years at London University as Kedday Fletcher Warr Student.

Dr. Glascock, who is married and has two children, lives at Arborfield in Berkshire. He is fond of gardening, "dislikes church bells." (*pages* 34-36)

TREVOR ILLTYD WILLIAMS (*History of Chemistry*) is Editor of *Endeavour* and Joint Editor of *A History of Technology*, a five-volume work now in the course of publication. At one time Dr. Williams was a Nuffield Research Student in the Sir William Dunn School of Pathology at Oxford, where he worked on antibiotics. His books include *Drugs from Plants* and *An Introduction to Chromatography*.

Dr. Williams is married, with three children. His recreations are gardening and fishing. (*page* 38)

CITY COMMENT

British Motor Corporation's achievement

AFTER falling from £23¼ millions in 1954-55 to less than £16 millions in 1955-56 the trading profits of the British Motor Corporation declined further, to £12¼ millions, in the year to 31 July last. This comparison is a reminder of the difficult conditions through which the motor industry has been passing. Its real significance, however, rests in its demonstration that the corner has been turned, for in the first half of the past year the group actually incurred a trading loss. In announcing this last March, when they added that no interim dividend would be paid, the directors did not state the amount of the loss. If it was £3¾ millions or more, then the group must have done fully as well during the second six months of the period as it did during the whole of 1955-56; if the loss was less than that the group must still have done nearly as well.

This impression of a phase of acute depression being followed by one of great buoyancy is borne out by Sir Leonard Lord's intimation that during the period the group changed successfully "from low gear into overdrive." B M C is a holding company whose chief operating subsidiaries are Austin Motor, Morris Motors and Fisher & Ludlow, the motor-car body makers. In the lean six months the group fared better than did the industry as a whole, for its share of registrations of new vehicles produced by the five leading manufacturers, which had been fairly consistently in the region of 40 per cent., rose each month until by last December it reached 50 per cent. Over the year its vehicle exports accounted for 51 per cent. of its total output, against 43 per cent. in the preceding period. This was largely due to the success of the group's sports cars in the U S, which actually displaced Australia from its traditional first position for B M C products in world markets. Nevertheless the Australian potentialities are being intensively developed, and already a lot of work has been done towards a combined programme of manufacture and assembly to satisfy at least 30 per cent. of the Australian market.

The capital investment in the new plant at Victoria Park, Sydney, was increased by a further £3,300,000 in the past year. All told the group spent over £7 millions in plant and buildings, and at 31 July it was still committed to contracts for capital expenditure estimated at well over £5 millions. The group's courage in adhering to its expansion plans through times of difficult trading has often excited remarks. The rationale of this boldness is given in Sir Leonard's words: "We feel sure that the limit of world demand for motor vehicles is not yet in sight. That is the constant factor behind and beyond all passing phases."

One factor supporting the great physical expansion is the group's possession of cash and other quick resources totalling nearly £18 millions. Another is the current revival in trade. Over the past year as a whole the group's production was down from 439,558 vehicles to 352,855 vehicles; but from 51,407 vehicles in the first quarter it rose to 123,341 in the fourth, representing an output rate of close to half-a-million annually. For the current year the chairman reports a good start and encouraging prospects. Despite the omission of an interim dividend earlier on, shareholders are after all receiving for the past year the same distribution, 12½ per cent., as for 1955-56. It is covered with a small balance to spare by the net profit of £2,819,468, which goes against £5,385,523 earned in 1955-56. The indications are that in the current year a similar payment will leave scope for much larger profit retentions.

BSA recovery

THE internal reorganisation of the Birmingham Small Arms Company is bringing results. In a difficult year for engineering concerns, that ended on 31 July last, the group increased its trading profit from £1,604,941 to £2,202,666. This is still some distance from the level of £2,865,676 reached in 1954-55, but the dividend, which was reduced a year ago from 10 per cent. to 8 per cent., is now restored to the higher rate. With the Preference dividends it takes £341,680 of a net profit of £1,582,370. This includes a net surplus of £269,811 secured on the sale of the pedal cycle section, but the earlier figure likewise included a surplus of £229,117 secured on the sale of the Birtley earth-moving equipment assets. Combined with the greater profitability of the year these transactions have helped to convert a group bank overdraft of £2,630,348 outstanding a year ago into a cash balance of £66,944.

This change has been wrought despite the expenditure of £1¼ millions on the fixed assets of the remaining sections of the business. In order of their importance for their contribution to turnover these are: Motor cycles and autocycles 27 per cent.; machine tools and small tools 23 per cent.; steel and titanium 18 per cent.; the Daimler Company (motor cars and buses) 14 per cent.; and small arms, general engineering, etc., 18 per cent. These sections do not contribute to profits in the same ratios. In particular, the Daimler Company incurred a loss in the past year, though this was "very substantially reduced" from the previous figure. This section of the business may have to be nursed along for some time yet, and the machine tool is affected by the current recession in the industry, though additional manufacturing facilities are being provided to meet the expanding demand for automation. Against that, the motor cycle companies, which account for over 60 per cent. of the total output of the British motor cycle industry, have staged a smart recovery and will soon be going into production with a scooter. The production facilities of BSA Guns are reckoned to be probably the best of their kind in Europe. The load of work on hand in the steel division is still satisfactory. Mr. John Y. Sangster, the chairman, notes that here technological advances are at an ever-increasing tempo. The requirements in special steels and in the high strength materials for supersonic aircraft, guided missiles, atomic energy plants and other advanced types of engineering call for new methods of production, inspection and examination, and this is being recognised in a development programme which will involve a capital expenditure of £1½ millions spread over the next three-and-a-half years. As part of the programme the vacuum-melting process, which has been applied to titanium for some time and is now being applied to steel, will be expanded. The BSA steel division was first in the field in this country with this process, which significantly improves the strength and other physical properties of steel, thus giving a greater strength/weight ratio which is so important in many engineering applications.

A GUIDE TO CAREERS

No. 54—Safety officer

From the Industrial Safety Division, Royal Society for the Prevention of Accidents

EVERY day something like 60,000 people are away from work as a result of injuries sustained in their employment. The consequent loss of production is far greater than is caused by industrial disputes, and may be estimated as at least £100 million a year. Every fresh advance in manufacturing techniques, and the development of new processes, carry with them the risk of new forms of injury. In recent years the risk of dermatitis has increased from innovations in the chemical industry, and the dangers of ionising radiation from X-ray processes and the use of nuclear energy are widely recognised. Modern high-speed machinery also rings new changes on old risks: bursting abrasive wheels are a particularly dangerous hazard. Dust, an old enemy in many processes, is also assuming new forms, and toxic effects, often unsuspected until they show themselves, are shown by metallic and plastic powders.

All this offers increasing scope for the work of the Safety Officer in industry, and there is now evidence that British industry is beginning to become more safety-conscious. Contrary to what is generally assumed, the overwhelming majority of accidents in industry are not caused by machinery. Accidents in the course of handling goods account for rather more than a quarter of all cases, while machinery, including transport, is responsible for only some 21 per cent. About the same number of accidents arise from people falling or treading on some object left lying about, and most of the remainder are attributable to hand tools and falling objects.

The work of the safety officer will naturally vary greatly according to the particular hazards of the factory or other place where he is employed, and also the size of the organisation. In a large works several officers will be required, and a degree of specialisation will probably be called for, whereas in a small organisation the safety officer will be expected to look after all aspects of eliminating accidents and injury.

Broadly speaking, it is open to anyone to become a safety officer. Policy in different firms varies widely, and while some will combine the work of accident prevention with a maintenance job, it is probably best to connect it with the planning department, where one exists. The most important attributes of a safety officer are the understanding of his work and the ability to make his advice and recommendations carry weight. He must therefore be able to command the confidence both of management and the workers at all levels, and this is particularly important, as he may well have to suggest schemes which appear to react against the material interests of one group or another.

Mastery of the Factory Acts is an important qualification, as the safety officer must be able to interpret their requirements and be quick to correct any breaches. But only about one-sixth of accidents arise from neglect of the provisions of these Acts, and combating the remainder calls for a wide range of knowledge. Besides being familiar with the techniques employed in the works (though undue familiarity can here, as elsewhere, breed a dangerous contempt), the safety officer needs an eye for what might be called housekeeping, that is, to see that no dangerous objects are left lying about, that stores are properly stacked, that lighting is adequate, and that loads are efficiently secured. It goes without saying that he must keep a constant eye on the guards and fencing of dangerous machinery. An even more valuable asset than conscientious observance of all these requirements is the ability to create in the works a positive attitude to safety among the other employees, and an understanding of possible hazards on the part of technicians.

Two other important qualifications may be mentioned: the ability to interpret plans and drawings so as to visualise possible hazards and eliminate them, and the competence to write a good report, accurately pin-pointing the weak link in the chain of circumstances causing any particular accident.

Most safety officers take up the work through nomination to a short training course run by the Royal Society for the Prevention of Accidents. Employers select men at all levels to attend these courses: in the case of small firms a director may well be chosen, while large organisations will naturally send men lower in the management scale. In many cases the initiative comes from the would-be safety officer himself, particularly where no such post already exists.

There are no precise academic qualifications for the course. The recruit will, of course, need an understanding of the technical processes of his particular firm, which will usually involve a knowledge of physics, chemistry or engineering of at least G C E standard. Much of the emphasis of the Royal Society's course is on the hazards arising in factories and on the Factory Acts, not the mere mastery of the text, but also the interpretation of them which will enable the safety officer to undertake the practical design of guarding for machinery and to follow the other provisions effectively. It is significant that machines with safety devices which have been incorporated in advance are far more popular with operators than those which have them attached subsequently. As such a high proportion of accidents with machinery is due to failure to use these devices, the importance of good advance planning is obvious, and plays a big part in creating the right attitude to safety in the workshop.

After one year's actual safety work, the officer becomes eligible for membership of the Institution of Industrial Safety Officers, and as from January 1, will be called on to sit a short examination, comprising papers on the Factory Acts; the Practice of Accident Prevention; Report Writing, and an oral test.

Safety officers find committee meetings and conferences provide good opportunities for extending their knowledge and picking up useful lessons from the experience of others, and most of them attend these in their own time. The keen man will soon find that his job is far more than mere employment, but takes on the character of a satisfying vocation. The path of entry and progress in this career is one of the most easily accessible in modern industry to the man who knows where he is going, and what he wants to do. But very many more will need to take it before we have anything like the ideal number of safety officers, which has been put at one to every thousand workers.

CLASSIFIED ADVERTISEMENTS

The rate for classified advertisements is 7s. a line (or space equivalent of a line), with an extra charge of 1s. for the use of a Box Number. Late classified advertisements can be accepted up to first post Monday for inclusion in the same week's issue.

REPLIES TO BOX NUMBERS should be addressed to the Box Number given, c/o **THE NEW SCIENTIST, Cromwell House, Fulwood Place, High Holborn, London, W.C.1. Tel.: HOLborn 7554.**

Orders for classified advertisements are accepted subject to the terms and conditions shown on the advertisement rate card, a copy of which will be sent on request.

OFFICIAL APPOINTMENTS

7s. per line—Box Number 1s. extra

UNIVERSITY OF WESTERN AUSTRALIA

Applications are invited for two **READERSHIPS IN MATHEMATICS**, one in the field of Pure Mathematics and the other in the field of Applied Mathematics.

The Salary range for Readers is £A2,200-£2,400 per annum plus cost of living allowance (at present £53) and the commencing salary will be determined on the basis of the qualifications and experience of the appointee.

An allowance is made towards travelling expenses and housing assistance is available.

Further particulars are available from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36, Gordon Square, London, W.C.1.

The closing date for the receipt of applications in Australia and London is 28TH FEBRUARY, 1958.

UNIVERSITY OF WESTERN AUSTRALIA

Applications are invited for appointment as a **SENIOR LECTURER IN PURE OR APPLIED MATHEMATICS** in the Department of Mathematics.

The salary range for Senior Lecturers is £A1,850-£A2,150 per annum, plus cost of living allowance (at present £53), and the commencing salary will be determined on the basis of the qualifications and experience of the appointee.

An allowance is made towards travelling expenses and housing assistance is available.

Further particulars are available from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36, Gordon Square, London, W.C.1.

Applications close in Australia and London on 28TH FEBRUARY, 1958.

UNIVERSITY OF WESTERN AUSTRALIA

Applications are invited for appointment as a **LECTURER IN PURE OR APPLIED MATHEMATICS** in the Department of Mathematics.

The salary range for Lecturers is £A1,250-£A1,750 per annum plus cost of living allowance (at present £53), and the commencing salary will be determined on the basis of the qualifications and experience of the appointee.

An allowance is made towards travelling expenses and housing assistance is available.

Further particulars are available from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36, Gordon Square, London, W.C.1.

Applications close in Australia and London on 28TH FEBRUARY, 1958.

CENTRAL ELECTRICITY AUTHORITY

MIDLANDS DIVISION

A **FOURTH ASSISTANT ENGINEER** is required in the Tele-Communications Section of the Technical Department, N.J.B. service conditions, superannuable appointment, salary within Schedule "B" Grade 8, commencing in range £710 to £835, ultimately rising to £935 per annum.

Preference will be given to candidates who have had experience with tele-communications equipment, and the possession of a qualification equivalent to the Higher National Certificate in Electrical Engineering would be an advantage.

Apply, quoting Vacancy No. 695MD on form AF6, available from the Establishments Officer, 53, Wake Green Road, Moseley, Birmingham, 13, by 31ST DECEMBER, 1957.

THE UNIVERSITY OF MANCHESTER

Applications are invited for the post of LECTURER IN ENGINEERING (MECHANICAL). A knowledge of Nuclear Engineering, Heat Transfer or Mechanical Design would be an advantage. University regulations permit teaching staff to read for the degrees of M.Sc and Ph.D. Applications will also be considered from engineers who would be interested in a temporary appointment of two or more years. The salary scale is £960 to £1,650 per annum. Membership of the F.S.S.U. and Children's Allowance Scheme. Initial salary according to qualifications and experience. Applications should be sent not later than 31st December, 1957, to THE REGISTRAR, THE UNIVERSITY, MANCHESTER 13, from whom further particulars and forms of application may be obtained. Applications (on the proper forms) will be considered from overseas candidates.

THE INSTITUTE OF LARYNGOLOGY AND OTOLOGY

(University of London)

330/332, Gray's Inn Road, London, W.C.1.

PHYSIOLOGICAL RESEARCH ASSISTANT

Applications are invited for this appointment in the Otological Investigation Unit. The work of the unit includes investigation of the physiological reaction of the two parts of the internal ear in the human subject and also experimental research in the physiology and neurophysiology of the acoustic and vestibular system. Candidates, who should be University graduates, should have had experience of experimental methods and of neurophysiology. The salary will be on scale £850 to £1,050 plus £60 London allowance and the starting point will be calculated according to the experience and qualification of the candidate chosen. Applications, giving full particulars of experience and the names of two referees, should be forwarded to The Secretary without delay.

CANTERBURY AGRICULTURAL COLLEGE

(University of New Zealand)

Applications are invited for the position of PROFESSOR OF PLANT SCIENCE (AGRICULTURAL BOTANY), to take up duties as soon as possible. Applicants should hold a University Degree in Science or in Agriculture, with special qualifications and experience in teaching or research.

Salary £2,190 per annum.

Conditions of appointment are available from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36, Gordon Square, London, W.C.1. Applications close in New Zealand and London on 15 FEBRUARY 1958.

EXECUTIVE ENGINEER
Public Works Department,
GAMBIA

Duties: Design and supervision in the field of general Civil Engineering works such as Roads, Buildings, Waterworks including the taking off quantities and specifications.

Appointment on probation for permanent and pensionable establishment. Gross emoluments in incremental range £1,086 to £1,680 per annum; Free Passages; Limited Free Medical Attention; Generous leave; Low Income Tax.

Candidate should be A.M.I.C.E., or have either:

(a) A University degree in civil engineering recognised by the Institution of Civil Engineers and two years' subsequent experience; or

(b) Passed Parts I and II Finals of the Institution of Civil Engineers or obtained a recognised diploma and had not less than five years' general experience on civil engineering work.

Additional professional experience and service in the Forces will be considered in determining starting salary. Some knowledge of sea or river works would be an advantage.

Apply DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1. Give brief details of age, qualifications and experience, Quote BCD 112/12/02/D45.

ROYAL MILITARY COLLEGE OF SCIENCE, SHRIVENHAM, BERKSHIRE, requires two male graduate demonstrators in each of following subjects: Physics, Chemistry, Civil and Mechanical Engineering. Excellent facilities for research work and conditions similar to those of residential university. Salary scale £630 to £760; starting salary according to age and experience. Superannuable under F.S.U. Accommodation for married officers' mess for single men. Forms and particulars from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A.30/7A. Closing date 30 December, 1957.

CENTRAL ELECTRICITY AUTHORITY

SOUTH EASTERN DIVISION

Kingston "B" Generating Station

FIRST ASSISTANT CHEMIST

Applicants should preferably possess H.N.C. or equivalent, should be experienced in the chemistry of water, coal and oil, and in the general control of raw and feed water treatment. Ability to think quickly and clearly in a practical context and to co-operate effectively with other departments a considerable advantage.

Salary Class G, Grade 9, £885-£930 per annum including London Allowance.

Applications stating details of education, experience, etc., should be sent to Station Superintendent, Kingston "B" Power Station, Lower Ham Road, Kingston-on-Thames, Surrey, so as to arrive by 21st December, quoting reference (355).

FISHERIES LABORATORY, LOWESTOFT. The Civil Service Commissioners invite applications for two pensionable posts under the MINISTRY OF AGRICULTURE, FISHERIES AND FOOD.

Post (a) for a PHYSICIST for appointment as Scientific Officer or Senior Scientific Officer according to age, qualifications and experience. Candidates must have a First or Second Class Honours degree in Physics or other appropriate subject and should have the inclination and ability to understand physical oceanography as represented by such works as Sverdrup's "The Oceans" or Proudman's "Dynamical Oceanography."

Candidates for appointment at Senior Scientific Officer level must have at least 3 years post-graduate or other approved experience.

The duties are to advance knowledge of such problems as the depth reached by turbulent movement at the surface; the penetration of light as it may effect biological production in various waters; the movements of water and variations which may mean success or failure of broods of planktonic fish larvae; the connections, if any, between the fluctuations in the movements of water masses as observed in widely separated areas of observation.

Post (b) for a FIELD HEAD PHYSICIST and RADIO CHEMICAL INSPECTOR and graded as Senior Scientific Officer. Candidates must have a First or Second Class Honours degree in Physics or Chemistry with experience or training in radioactivity.

The duties will include the collection and assessment of monitoring data and the design of new monitoring programmes. There will be considerable opportunity for progress within the field of health problems associated with disposal of radioactive wastes, and close association with officers of the Atomic Energy Authority and Ministry of Housing and Local Government.

All scientific staff of the Fisheries Department serve at sea in research vessels for up to 90 days per annum.

Exceptionally a candidate without the prescribed academic qualifications but otherwise well qualified may be admitted.

Age at least 21 but normally no candidate under 26 will be appointed initially to the senior grade.

S.S.O. salary scale, £970—£1,380; starting salary above minimum of exceptionally well qualified.

S.O. scale, £595—£1,050; higher starting pay for approved candidates and compulsory Forces service. Women's salary somewhat lower but being improved under equal pay scheme.

Candidates must apply through the normal open competitions for these grades to Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4771/53/57, if they wish to apply for the S.S.O. grade or S.4771/52/57 for the S.O. grade.

Application forms should be returned by 31 DECEMBER 1957.

OFFICIAL APPOINTMENTS—*contd.*

SOUTH AFRICAN BUREAU OF STANDARDS

METALLURGIST

Applications are invited for the post of Metallurgist at the South African Bureau of Standards, Pretoria. Candidates should hold a University degree and have had at least five years' experience covering, if possible, metallurgy and hot ferrous and non-ferrous metallurgy. Salary will be on the scale £1,080 x £60—£1,380, the starting salary depending upon experience and qualifications. A cost of living allowance of £234 p.a. is payable to married male officers.

The Council has a five-day week, generous leave privileges, leave bonus and provident fund. Passages to South Africa of the selected candidate and his family will be paid.

Further information and application forms are obtainable from the SOUTH AFRICAN SCIENTIFIC LIAISON OFFICER, AFRICA HOUSE, KINGSWAY, LONDON, W.C.2.

WAKEFIELD TECHNICAL AND ART COLLEGE

APPOINTMENT OF LABORATORY STEWARD.

Applications are invited for the post of LABORATORY STEWARD. Duties will be concerned primarily with Electrical and Mechanical laboratories. Experience of electrical engineering and installation work would be an advantage.

SALARY SCALE: £453 x £15 (3) x £20 (1)—£518 per annum.

Further information and forms of application which should be returned within 15 days of the issue of this advertisement, may be obtained from the undersigned.

C. L. BERRY,
Director of Education.

Education Department,
27, Kirk Street,
WAKEFIELD.

UNIVERSITY OF OTAGO

Dunedin, New Zealand.

Applications are invited for the position of SENIOR LECTURER OR LECTURER IN ZOOLOGY.

Salary range, Lecturer £1,025—£1,275 per annum; Senior Lecturer £1,315—£1,615 per annum.

Further particulars are available from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36, Gordon Square, London, W.C.1.

Applications close in New Zealand and London on 30 JANUARY 1958.

THE UNITED NEWCASTLE UPON TYNE HOSPITALS

Royal Victoria Infirmary.

A vacancy exists at the above hospital for a TECHNICIAN in the Department of Bacteriology.

Applicants must be Associates of the Institute of Medical Laboratory Technology or possess equivalent qualifications (e.g., B.Sc.).

The terms and conditions of the appointment will be in accordance with the agreements of the Whitley Council for the National Health Service and the salary will be on the scale £515 x £30 per annum.

Applications, together with the names and addresses of two referees should be sent to the House Governor and Secretary, Royal Victoria Infirmary, Newcastle upon Tyne.

MIDDLESEX COUNTY COUNCIL

Education Committee

BRUNEL COLLEGE OF TECHNOLOGY, Woodlands Avenue, Acton, W.3.

Appleations are invited for the post of:—

SENIOR LECTURER in PSYCHOLOGY in the Department of Management and Production Engineering. Candidates should have a degree in psychology, preferably with biology, mathematics or physics; an ability to supervise Diploma in Technology students in their studies of perception and skill and to use research opportunities with local firms, preferably in exploring the possibilities of using information theory in the analysis of human performance.

Salary in accordance with the Burnham (Technical) Report, 1956. i.e., £1,350 x £50—£1,550 plus London allowance.

Application forms (stamped addressed foolscap envelope) from the Principal to whom completed forms should be returned within 14 days of the appearance of this advertisement.

C. E. GURR, M.Sc., Ph.D.,
Secretary to the Education Committee.

CENTRAL ELECTRICITY AUTHORITY

MIDLANDS DIVISION

FOURTH ASSISTANT ENGINEER is required in the Protective Gear Section of the Technical Department, N.J.B. service conditions, superannuable appointment, salary within Schedule "B," Grade 8, commencing in range £710-£835 ultimately rising to £935 per annum.

A university degree, Higher National Certificate or equivalent qualification is desirable. Some knowledge of protective gear is required, and preferably experience with a switchgear manufacturer.

Apply, quoting Vacancy Number 954MD, on form AE6, available from the Establishments Officer, 53, Wake Green Road, Moseley, Birmingham, 13, by 19TH DECEMBER, 1957.

GHANA PUBLIC SERVICE COMMISSION

Applications invited for the post of GOVERNMENT CHEMIST in the Ministry of Health to analyse foods, drugs, wines, spirits, textiles, and pathological samples including poisons. Contract appointment with gratuity. Salary according to experience in scale £1,080-£2,080. Outfit and Children's Education Allowances. Free passages for officer, wife and up to three children under 18 years. Quarters at low rental. Tour of service 24 months. Generous home leave. Low income tax.

Candidates should have either (a) a good University degree in science including chemistry, or (b) obtained Associate membership of the Royal Institute of Chemistry under arrangements in force prior to 1st July, 1956, or Graduate Membership of the Institute under arrangements brought into force on 1st July, 1956.

For further particulars and application form write, stating age and experience to THE DIRECTOR OF RECRUITMENT, GHANA HIGH COMMISSIONER'S OFFICE, 13, BELGRAVE SQUARE, LONDON, S.W.1. Closing date for initial inquiries 27th December.

EASTERN GAS BOARD

(Cambridge Division), Bedford District.

DRAUGHTSMAN

Applications are invited from suitably qualified persons for the position of draughtsman at the above undertaking. Applicants must preferably have had experience of Gas Works Plant and equipment and general drawing office routine.

The salary will be commensurate with the experience of the person appointed.

The successful candidate will be required to pass a medical examination, and unless already subject to a Pension Scheme by virtue of the Gas (Pension Rights) Regulations 1950, will be required, if eligible, to join the Board's Staff Pension Scheme within six months of taking up the appointment.

Applications, stating age and giving full particulars of qualifications and experience with the names of two referees, should be sent to the General Manager, 52, Sidney Street, Cambridge, within fourteen days of the appearance of this advertisement.

APPOINTMENTS AND SITUATIONS VACANT

7s. per line—Box Number 1s. extra.

THE PHYSICS AND CHEMISTRY OF GLASS POLISHING

Among the products of THORIUM LIMITED, manufacturers of rare earth (lanthanon) chemicals, are glass polishing powders based on cerium oxide. A well-qualified young graduate in PHYSICAL CHEMISTRY or PHYSICS is required to carry out an investigation into the mechanism of glass polishing and the production of polishing powders. The vacancy is at the firm's research laboratories in Ilford which are well-equipped and modern. Conditions of employment are in line with normal practice and the maximum commencing salary envisaged for the appointment is £1,000 per annum. Applications are invited from honours graduates with or without some industrial experience. The age limit is 27. Further information can be obtained from the Research Manager, THORIUM LIMITED, UPHALL ROAD, ILFORD, ESSEX.

LECTURER REQUIRED

by the IRAQ PETROLEUM COMPANY to lecture in Chemistry and Physics with particular application to Petroleum Technology under the general direction of the head of the Engineering Science Section of the Industrial Training Centre, Kirkuk. He will be required to plan the details of instruction and teach senior Iraqi apprentices according to the syllabus of the Chemistry and Physics courses of the Union of Lancashire and Cheshire Institute and the City and Guilds Intermediate Petroleum Technology course. An important part of his work will be the follow-up of apprentices attached to Departments for on-the-job training. Should have degree or H.N.C. or equivalent plus recognised diploma of education and at least five years' experience as Assistant Lecturer with preferably some overseas work. Industrial experience an advantage. Age limit 35. Pensionable emoluments from £1,185 plus generous allowances. Annual leave with paid passages. Fully furnished accommodation but married applicants should be prepared for 12 months' separation. Service is recognised by Ministry of Education. Reply in detail quoting No. 666 to Box No. 1319, c/o Charles Barker and Sons Ltd, Gateway House, London, E.C.4.

B.B.C. ENGINEERING DIVISION has a number of vacancies in the Operations and Maintenance Departments for Probationary Technical Assistants in the Sound and Television Services for maintenance duties. Applications are invited from male British Subjects aged 20-25, who have completed their National Service, are normally resident in Great Britain or Northern Ireland and whose qualifications include G.C.E. in English Mathematics, Physics, or General Science, a good knowledge of the fundamentals of audio and radio engineering and practical experience, other than operational, in radar, radio or electronics, gained either in industry or H.M. Forces. Starting salary £515, rising by 7 annual increments to £750 p.a. Further particulars from Engineering Establishment Officer, Broadcasting House, London, W.1, quoting reference N.S.4.

A GOOD JOB

of great variety and interest for a

TECHNICAL WRITER

FOR ELECTRONIC COMPUTER DEVELOPMENT WORK

The Electronic Research Laboratories of The British Tabulating Machine Co. Ltd. are in the forefront of advanced electronics applied to business machines and computers for integrated data processing. They offer exceptional positions to men capable of making valuable contributions to this work . . . and who are interested in the rewards this large Company offers for individual achievement and merit.

Immediately, we have an opening for a man able to write lucidly and who is qualified, by some years in the design, engineering or maintenance of electronic equipment, to handle the writing of service manuals, handbooks and research reports on laboratory progress.

As we serve every aspect of industry, commerce, national research establishments, government and local government, both at home and overseas, the uses for our equipment are many and varied. The work is of constant interest, and provides exceptional experience in every phase of digital computer development. Training will be given to engineers who may be otherwise qualified, but who have had little or no experience with electronic computers.

Promotion is by individual achievement; working conditions are very pleasant and the salary offered will be well in keeping with the qualifications expected. A Pension Scheme is operated.

Write, giving personal details and experience, quoting Ref. No. T.W.1; to: Head of Research, THE BRITISH TABULATING MACHINE CO. LTD., Electronics Research Laboratories, Gunnels Wood Road, Stevenage, Herts.

APPOINTMENTS AND SITUATIONS VACANT—*continued*

STATISTICIAN

The Research and Development Branch of the Industrial Group of the United Kingdom Atomic Energy Authority has a vacancy at Capenhurst Works, Chester, for a statistician to join a team of mathematicians and theoretical physicists, which is chiefly concerned with operational problems of the gaseous diffusion plant. The statistical work involves the design and assessment of plant experiments, studies of factors affecting output, efficient operation of the plant and component reliability, and assessment of control and maintenance procedures. Questions of experimental design and analysis are also posed by other sections of the Laboratory which is primarily concerned with mechanical engineering development.

Applicants must have at least a second class Honours Degree in Mathematics or Statistics or an equivalent qualification. Experience in the field of experimental design, sequential analysis and stochastic problems of an operational research nature is desirable.

Salary will be assessed according to age, qualifications and experience within the scale £1,215-£1,425 or £645-£1,120.

Contributory pension scheme in operation.

A house for renting by the successful candidate, if married, may be available in due course or, alternatively, substantial assistance may be given towards legal expenses incurred in private purchase.

Send postcard for application form, quoting reference 2144, to Recruitment Officer, U.K.A.E.A., I.G. Hq., Risley, Warrington, Lancashire.

Closing Date—23rd December, 1957.

A.E.I.—JOHN THOMPSON NUCLEAR ENERGY COMPANY LIMITED, RADBROKE HALL, KNUTSFORD, CHESHIRE. An EXPERIMENTAL PHYSICIST is required to take part in a programme of Research into the Nuclear Physics of gas-cooled Power Reactors. This programme has been planned in collaboration by the Industrial Organisations and Natural Authorities engaged in this field.

The successful candidate will join a small team which is investigating the neutron-multiplying properties of advanced Graphite/Uranium Reactor Cores. The work involves planning experiments, and analysing and interpreting the results. Experimental facilities have been provided on a generous scale, and technical and computational assistance is available. The work is located at a major Research Establishment in the South of England.

Applications are invited from Physicists with Postgraduate experience in making precise physical measurements. A knowledge of experimental techniques in Nuclear Physics would be an additional qualification.

The post is a permanent pensionable appointment and applications should be made to the Chief Engineer, quoting Reference RED/PRJF.

APPLICATION ENGINEER

A vacancy occurs in the Sales Organisation of ELLIOTT BROS. (LONDON) LTD., for an Internal Sales Engineer in the field of Instrumentation in the Chemical and Oil Industries. Applicants should be of at least H.N.C. standard and a good knowledge of Chemical Process Engineering techniques is a valuable asset. Good starting salary. Pension Scheme. Please apply, giving full details of career, to Personnel Officer, Century Works, Conington Road, Lewisham, S.E.13.

METALLURGIST required for research and development laboratory. Must be fully conversant with heat-treatment techniques and preferably have a knowledge of metallography and physical methods of analysis. Permanent position with good future prospects. Pension Scheme. Apply in writing to—Chief Metallurgist, WILD-BARFIELD ELECTRIC FURNACES, LTD., Elecfurn Works, Watford By-Pass, Watford, Herts.

DRAUGHTSMAN

H. J. Heinz Company Limited have a vacancy for a DRAUGHTSMAN for ELECTRICAL SERVICES. Applicants should be aged 25-40, with a minimum of 5 years' Drawing Office experience, and be familiar with all aspects of main and subsidiary electrical services and should preferably be of H.N.C. Standard.

Please apply to the Personnel Officer, H. J. HEINZ COMPANY LIMITED, Watkiss Road, Harlesden, London, N.W.10.

THE SHELL GROUP OF COMPANIES

require

ENGINEERS

For service, primarily overseas, in their marketing organisation. Initial duties comprise planning, construction, maintenance and operation of bulk petroleum storage plants and other distribution facilities. The variety of jobs performed in the early stages of such a career provides administrative training and experience so that those starting along this route have equal opportunities with others to compete for the highest posts in management. Candidates should be qualified Engineers and aged between 24 and 28 years and preference given to men with a University Degree in Engineering.

Please write giving full details to:—

THE SHELL PETROLEUM COMPANY LIMITED,
Recruitment Division/O.D.,
16, Finsbury Circus, London, E.C.2.

RESEARCH ASSISTANT. A progressive company producing glass fabrics for reinforced plastics and other industrial purposes requires an assistant to work under its Chief Chemist. Applicants must have G.C.E. (advanced level) or Inter.B.Sc. in chemistry and be between 21 and 26. Write giving particulars of education, age, domestic circumstances, details of industrial or academic experience, and salary required. The post is a progressive one and a contributory pension scheme is in operation. Applications to the Managing Director, MARGLASS LTD., Sherborne, Dorset.

GILLETTE INDUSTRIES LIMITED

invite applications for the following appointments:—

ASSISTANT PRODUCTION MANAGERS. Age range 26–32 years. Requirements: G.C.E. examinations, preferably "A" level in science subjects. A mechanical engineering qualification—minimum O.N.C. Workshop experience in light engineering. Forceful and adaptable personality with leadership ability.

Duties would involve assisting Production Managers in their general administrative duties with regard to production, processes, plant, personnel, etc. REF. No. FAS/34.

Vacancies also exist on the Chief Engineer's staff for:—

MECHANICAL DESIGN ENGINEER. Age range 24—35 years. Requirements: H.N.C. (Mechanical Eng.). Knowledge of Work Study as applied to Project Engineering. General engineering experience applied to precision products with an intimate knowledge of mass production techniques. This should include drawing office experience. Tactful yet forceful personality.

The successful candidate would be engaged upon Process Engineering developments. REF. No. FAS/32.

ESTIMATING ENGINEER. Age range 25—35 years. Requirements: O.N.C. (Mech.) Estimating ability as applied to Tooling and Machinery. Practical engineering experience applied to precision products.

The job would involve estimating machine hours for all Tooling and Machinery manufacture which would include Machine Shop Loading and the production of initial cost estimation. REF. No. FAS/33.

Salaries for these positions will be paid according to qualifications and experience. Benefits include non-contributory pension and married man's life insurance scheme and contributory provident fund. Applications in writing, which will be treated in confidence, should give full details of age, education, qualifications, experience and present salary and should be addressed to the Personnel Controller, Gillette Industries Limited, Great West Road, Isleworth, Middlesex, quoting the appropriate reference on both envelope and letter.

Opportunities for

ELECTRONIC ENGINEERS

in the

Guided Missiles Division

of

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LIMITED

Because of expanding commitments the Company wishes to increase its electronic engineering staff to deal with information problems involved in the development of telemetry and associated systems.

This is an outstanding opportunity to join a newly formed research team in the field of electronic engineering.

Qualifications: degree in Physics or Electronic Engineering with experience in developing electronic equipment from basic circuitry.

If you possess drive, ambition, and the capacity for original thought, then you are the man we require. All applications will be treated in the strictest confidence and should be addressed to:

Technical Appointments Officer,
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.
Baginton, Nr. Coventry.

Quoting reference Elec/S.P./3.

ABBOTT LABORATORIES LTD., manufacturers of fine pharmaceuticals, offer careers in commerce to young men between 25 and 35 years who have had training in medical, scientific or allied subjects.

These appointments are in the sales organisation, involving personal contact with the medical profession, and call for a measure of initiative and a real sense of personal responsibility. Every encouragement is given to develop individual character, and men of strong but pleasing personality can establish a future for themselves with considerable prospects.

A thorough training will be given, after which a car will be provided, and successful applicants will become members of the company's pension scheme after a suitable qualifying period.

Vacancies occur in Yorkshire and other parts of the country.

Applications, in own handwriting, giving the fullest details and stating whether able to move to any specified part of the country, should be addressed to the Sales Manager, Abbott Laboratories Ltd., Bede Trading Estate, Jarrow, Co. Durham.

PFIZER LTD.

SENIOR TECHNICIAN

required for

Control Laboratory, Folkestone.

Experience in modern analytical techniques desirable with special reference to analyses of pharmaceutical preparations. Good prospects. Non-contributory Pension Scheme in operation.

Write, giving full details of experience, etc., to Personnel Officer, PFIZER LTD., 137/139, SANDGATE ROAD, FOLKESTONE.

AN ECONOMIST/STATISTICIAN is required by The Mond Nickel Company Limited for its STATISTICAL DEPARTMENT. Honours degree in economics with statistics as a special subject preferable. Good knowledge of German and/or French desirable.

Salary will be in accordance with experience and qualifications. Pension and assurance schemes are in operation and, in appropriate cases, assistance can be given with housing. Applications, which will be treated in confidence, should give details of age, qualifications and experience and be addressed to A. E. Jenkins, Statistical Department, THE MOND NICKEL COMPANY, Thames House, Millbank, London, S.W.1. Mark envelope "Confidential 671."

APPOINTMENTS AND SITUATIONS VACANT—*continued*

LABOUR MANAGER required by the ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, Berks., for the following duties:—Industrial employment, trade union negotiations, joint consultative machinery and interpretation of the Authority's labour policy.

Applicants should be at least 30 years of age and have had considerable experience of Industrial Personnel Management covering some or all of the following aspects:—

Recruitment, trade union negotiations, joint consultation, education and training (with experience of job evaluation) and industrial welfare generally. A degree in social studies an advantage.

SALARY: £1,125 to £1,385 per annum.

Contributory Superannuation scheme. A house or assistance towards legal expenses on house purchase will be available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer, at above address. Please quote ref. 16/9/215.

BRITISH TITAN PRODUCTS COMPANY LTD.

have vacancies for

MECHANICAL ENGINEERS

at their Technical Headquarters
BILLINGHAM,
Co. Durham.

The Company is primarily concerned with the large scale manufacture of Titanium Dioxide and is characterised by a ten-fold expansion in post-war years. This continuing expansion is associated with a large number of interesting mechanical engineering design problems in existing and proposed new plants and processes.

Applications are invited from Honours degree graduates in Mechanical Engineering or those with equivalent professional qualifications. Some industrial experience is preferred but fresh graduates, including those who are at present engaged on National Service and who will be available some time in 1958, may also apply. The age range envisaged is 25-35 years.

Salaries and prospects are very attractive for men with the right qualities; conditions of work are good; Staff Bonus, Superannuation Scheme and non-contributory Life Assurance are in operation; housing assistance is available if required. Applications will be treated in the strictest confidence and should be addressed to the Personnel Manager, British Titan Products Co. Ltd., Coppergate, York, quoting reference S. 32.

CHEMIST.—A Chemist (aged 23-26), interested in organic and physical chemistry and with a good B.A. or B.Sc. honours degree, is required to join a team carrying out fundamental research. Well equipped laboratories; publication of original work encouraged. Grading Scheme. Post superannuable under F.S.S.U. 5-day week. Applications in writing to the Assistant Secretary, Ref. D.47, THE BRITISH COAL UTILISATION RESEARCH ASSOCIATION, Randalls Road, Leatherhead, Surrey.

ANALYTICAL CHEMIST

Magnesium Elektron Limited require a first-class Analytical Chemist to develop chemical and physical methods of inorganic analysis in a wide field. Applicants should have an honours degree or its equivalent and be capable of working on their own initiative in a modern and well equipped laboratory. Salary according to qualifications and experience. Contributory pension and life assurance scheme.

Please reply quoting reference SNS.32 and giving full details of qualifications and experience to Personnel Office (Staff), MAGNESIUM ELEKTRON LIMITED, P.O. Box No. 6, Lumm's Lane, Clifton Junction, Swinton, near Manchester.

MSL have been retained to advise on the appointment of a

CHIEF ENGINEER

for a company in the Home Counties employing 3,000 on the manufacture of light electro-mechanical products with a turnover of £3m.

The Chief Engineer will direct a well-qualified team of about 35 scientists and engineers designing electro-mechanical equipment for mass-production, and about 15 engineers responsible for layout, methods and production engineering.

After a probationary period of about 12 months at an initial salary of about £2,500 there is the prospect of promotion to the board with consequent improvement in remuneration.

Candidates should have a degree or professional qualification in electrical or mechanical engineering; have experience of the design of small electric motors; have led a development or research department; and be familiar with engineering administration. Preferred age 38-48.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference AQ.668 to T. E. Watson,

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

PHOTO-PRINTING RESEARCH. The Ozalid Research Laboratories have vacancies for MALE and FEMALE RESEARCH ASSISTANTS. Candidates, whose main interest should be in chemistry, should be free from military obligations and of at least Inter B.Sc. or National Certificate standard. Interesting work, pleasant working conditions and attractive salaries. Write to Technical Administration, OZALID COMPANY LTD., Lenthall Road, Loughton, Essex. Quote Ref. J.T./NS/6N.

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LIMITED

require the following staff for work in the

WIND TUNNEL DIVISION

PROGRAMMERS—experience in programming a Pegasus Digital Computer is desirable but not essential, as training will be given. Qualifications desired: Hons. degree in mathematics.

SENIOR DESIGN DRAUGHTSMEN—candidates with experience in model design and a wide variety of wind tunnel equipment are preferred, experience in the design of servo mechanisms would be also be an advantage. Qualifications: H.N.C. or equivalent.

COMPUTER OPERATOR—a young lady between 16 yrs. and 21 yrs., is required to operate a Digital Computer. Preference will be given to applicants with a G.C.E. "A" level in Mathematics but "O" level would be acceptable. Previous experience is not essential as training will be given.

Initial salaries are related to qualification and experience and regular merit increases ensure a growing income. In addition there is a generous superannuation scheme in operation.

Applications should be addressed:

Technical Appointments Officer,
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.
Baginton, Nr. Coventry.

ASSISTANT MANAGER required for expanding TRANSFORMER DEPARTMENT. Experience desirable in design of most types of transformers up to 250 kVA. Good prospects for the right man. Bonus scheme. AUSTIN WALTERS & SON, LTD., AYRES ROAD, OLD TRAFFORD, MANCHESTER 16.

GRADUATE CHEMISTS

LEADING COMPANY of CHEMICAL MANUFACTURERS with a world-wide reputation for their specialised products have at the present exceptional opportunities for Graduate Chemists in their research organisation.

The work is largely concerned with titanium and aluminium products and a good second-class Honours degree is a minimum requirement.

The posts are open to graduates with some or no industrial experience and the starting salaries and conditions are excellent.

All replies will be treated in strict confidence and full details should be sent to G. Ll. JONES, PERSONNEL SELECTION AND TRAINING CONSULTANT, 11, Albert Square, Manchester 2.

LARGE ADVERTISING AGENCY requires TWO part-time INTERVIEWERS for motivation research. Candidates (men or women) should have had first-class experience in psychological, sociological or similar fields of research. Box No. C 189, The New Scientist, Cromwell House, Fulwood Place, W.C.1.

SEMI-CONDUCTORS !

TO GRADUATE PHYSICISTS, CHEMISTS, MECHANICAL AND ELECTRICAL ENGINEERS

(Aged 20-35 years)

THE GENERAL ELECTRIC CO. LTD.

offers at its Hazel Grove factory, in Cheshire, excellent opportunities of interesting work and advancement for graduates in this new and expanding field of technology.

A very wide range of opportunities exists covering the more technical aspects of development to more administrative yet still technical aspects of production. There are also positions of varying seniority, and scope exists for rapid advancement for men of ability.

The problems in the development and manufacture of semi-conductors, diodes and transistors, are mainly in Physics, Chemistry and Mechanical Engineering; Electrical Engineering as such, is not very relevant. However, the characteristics required are ability to learn rapidly, to think clearly and to work in a systematic and orderly manner over a wide range of technical problems.

Salaries offered and working conditions are first class, and the factory is conveniently situated near pleasant country housing areas.

Applicants should write in confidence giving details of qualifications and experience to the Personnel Manager:

SALFORD ELECTRICAL INSTRUMENTS LTD.
(Components Group), School St.,
Hazel Grove, Nr. Stockport, Cheshire.

The Company which is operating this project on behalf of the G.E.C. Ltd., England.

COMPANY developing Textile-Synthetic-Resin composite products require GRADUATE CHEMIST, preferably with Textile experience. The work calls for a responsible person with initiative, capable of carrying out and controlling development work on Laboratory and Factory Scale. Salary £800-£1,100 per annum according to qualifications, etc. Superannuation Scheme. Staff Appointment. Write, stating age, experience, etc., to Box No. C 187, The New Scientist, Cromwell House, Fulwood Place, W.C.1.

BAYER PRODUCTS LTD.

APPLICATIONS are invited from SCIENCE GRADUATES with an interest in bacteriology and immunology for two new posts at the Bayer Biological Institute in connection with the production of antisera and anaerobic vaccines for veterinary purposes. Salary according to qualifications and experience. Applications should be addressed to the Head of the Bayer Biological Institute, Beechwood House, Ewing, Newmarket, Suffolk.

APPOINTMENTS AND SITUATIONS VACANT—*continued*

PATENT AGENCY. Young man wishing to qualify for Chartered Institute of Patent Agents and holding a degree in chemistry, will be given training and experience in Patents Department of manufacturing chemists. Some previous industrial experience would be an advantage. The work involves the preparation and prosecution of Patent applications in the pharmaceutical field both in the United Kingdom and foreign countries. Post offers good prospects for candidate wishing to make a career in the Patents profession. Applications in writing to The Secretary, THE WELLCOME FOUNDATION LIMITED, The Wellcome Building, Euston Road, London, N.W.1.

STATISTICIAN

"SHELL" RESEARCH LIMITED

require a

MATHEMATICAL STATISTICIAN

preferable under 30 years of age for the Statistical Group at

THORNTON RESEARCH CENTRE

(near Chester).

The work consists of designing and analysing the results of extensive experiments in the application of fuels, lubricants, petroleum-derived chemicals and other products of the oil industry. Close collaboration with the large scientific staff is involved and some interest in engineering and general science is desirable. Working conditions are pleasant and prospects good. Five-day week and attractive pension scheme.

Applications should be addressed to "Shell" Research Limited, Staff Department (R/S), 16, Finsbury Circus, London, E.C.2.

A LARGE and expanding West Country Manufacturing Company requires a first (or possibly, second) class HONOURS MATHEMATICIAN, male or female, to complete, as the mathematical specialist, a team of other scientists working on a wide variety of interesting problems. Adequate salary will be offered according to age, qualifications and experience. Apply with brief particulars in the first instance to Box No.C183, The New Scientist, Cromwell House, Fulwood Place, W.C.1, and quote Ref. No. M26.NS.

THE CAMBRIDGE INSTRUMENT CO. LTD.

HEAD OFFICE: 13, GROSVENOR PLACE, LONDON, S.W.1

have several vacancies in their sales departments at Head Office and Friern Park, Finchley, N.12. Experience in methods for measuring temperature, flue gas and other gas analysis by katharometer methods and electrical laboratory measurements. Knowledge of application and commercial practice and procedure an advantage, but young candidates with scientific and technological education up to H.N.C. standard will be considered as trainees. Prospects of advancement are good. Salary is commensurate to experience and will be reviewed regularly. Every encouragement will be given to develop character and initiative.

Apply in writing to HEAD OFFICE AT ABOVE ADDRESS marking envelope reference 3/8 and giving details of education and career.

GRADUATE MATHEMATICIAN required for research department of diesel and electrical engineering firm in West London to join a small team of mathematicians currently on a range of problems. A computer is used where possible and in the first place the work will be on the various stages of preparation of problems for numerical solution. There is ample scope for the use of initiative and developing skills. Write stating age, qualifications and experience to the Personnel Manager, C.A.V. LIMITED, Warple Way, Acton, W.3, quoting Ref.: 328.

FOSTER WHEELER LIMITED

require

SENIOR DRAUGHTSMEN

for work in London on an Admiralty Nuclear Propulsion contract. Men having experience in the following fields would be preferred:—Pressure vessel design; Plant lay-out; High-pressure systems; Steam Generating Plant. Applicants should possess O.N.C. but preference would be given to those with H.N.C. The remuneration would be generous and appropriate to the applicant's capabilities. Staff Pension Scheme is operated. Apply in writing, stating age, qualifications and experience, to:—

Staff Manager (NP),
Foster Wheeler House,
3, Ixworth Place,
London, S.W.3.

CHEMIST, qualified, required for an Electronic Laboratory in the South Midlands. Responsibilities include running a small chemical laboratory, advising and checking plating solutions, and on all aspects of metal and non-metal finishes to withstand eliminatic conditions and would include the control of a small climatic testing unit. Experience of insulating materials, plastics and resins used in the electrical industry is essential. Applicants should have knowledge of Government specifications and inspection requirements. Reply stating age, qualifications, experience and salary required to Box No. C 190, The New Scientist, Cromwell House, Fulwood Place, W.C.1.

METALLURGICAL RESEARCH

GRADUATE PHYSICISTS, METALLURGISTS AND CHEMISTS are required by THE RESEARCH LABORATORIES of THE GENERAL ELECTRIC CO. LTD., NORTH WEMBLEY, MIDDLESEX, to assist with an expanding programme of work in a number of varied Metallurgical Research projects.

TECHNICAL ASSISTANTS, preferably up to O.N.C. standard, are also required to work on the above projects.

Please apply in writing to the Staff Manager (Ref. RL/6) giving full particulars of qualifications, experience and age.

CHEMIST. Attractive post for candidate with initiative and enthusiasm, under 35 years of age, B.Sc. preferred. Good opportunity for advancement in field of Resin, Glues and Starch Adhesives. Interest in sales service essential. Non-Contributory pension. Apply SWIFT AND COMPANY LIMITED, Adhesive Division, Spelthorne Lane, Ashford, Middlesex.

METALLURGIST

for research work on manipulation of aircraft and heat-resisting materials, lubrications, uses of radio-isotopes, etc. Age group 30-35. Highest possible academic qualifications consistent with practical engineering outlook. Apply Technical Director, TILTMAN LANGLEY LIMITED, Redhill Aerodrome, Surrey.

RESEARCH CHEMIST

University graduates in Chemistry with five or more years of research experience in some branch of Chemistry, preferably in industry, are invited to apply for a post as leader of a small research team investigating interesting problems connected with the development of new bulk chemicals. The laboratory is at present being extended and there is ample scope for a man with initiative and drive to settle down in a responsible position in an old-established company.

A four-figure salary or thereabouts is envisaged for a man with the right qualifications and experience.

Apply in confidence to: The Research Manager, THE STAVELEY IRON & CHEMICAL CO. LTD., Nr. Chesterfield, Derbyshire.

ASSISTANT EXPERIMENTAL OFFICER required by the ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, Berks., to assist in investigations concerning physical, physical chemical and explosive properties of new conventional explosives or on other materials used in association with them.

G.C.E. in at least five subjects including English language (ord.) and physics and chemistry (adv.) or H.S.C. (science) or equivalent required.

SALARY: £395 (at age 18)—£700 (at age 26 or over)—£855 p.a. Contributory Superannuation scheme. A house or assistance towards legal expenses on house purchase will be available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer at above address. Please quote ref. 1643/215.

ELECTRICAL ENGINEERS

or

PHYSICISTS

Qualified or equivalent, age 22—35, required for development and application of direct reading spectrographs.

Salary £700—£1,200 per annum, plus excellent expense allowance when away. Must be prepared to travel.

Applications to:

APPLIED RESEARCH LABORATORIES (G.B.) LTD.,

CEDARDALE WORKS, LUTON ROAD, HARPENDEN.

LABORATORY ASSISTANT. A vacancy exists, in the ATOMIC ENERGY DIVISION, in connection with the testing of prototype instruments and electro-mechanical devices for use in nuclear power plants. Applicants must have had experience of practical laboratory work and a technical education at least to H.N.C. standard. Please write giving full details to Personnel Manager, THE GENERAL ELECTRIC COMPANY LIMITED, FRASER & CHALMERS ENGINEERING WORKS, ERITH, KENT, quoting reference AED/48.

The Fairey Aviation Company Limited,

Hayes, Middlesex.

ASSISTANT WORKS CHEMIST

required with good all-round Analytical and Investigational experience and competence on metallic and non-metallic engineering materials.

Please apply giving details of career and qualifications to the Personnel Manager at Hayes.

PLASTICS CHEMIST OR TECHNOLOGIST required by Company specialising in extrusion and thermoplastic cables. Knowledge of die design and extrusion technique would be valuable. Box No. C188, The New Scientist, Cromwell House, Fulwood Place, W.C.1.

DEVELOPMENT ENGINEER

required by progressive medium-sized engineering organisation in West Midlands to work on the design and introduction of machines, plant and handling equipment for the manufacture of a specialised engineering product.

Qualifications required—H.N.C. or better. Age limit 45.

Salary range up to £1,250 p.a. depending on qualifications and experience. Please write, in confidence, to Box No. C191, The New Scientist, Cromwell House, Fulwood Place, W.C.1.

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APPOINTMENTS AND SITUATIONS VACANT—*continued*

GRADUATES wanted with a knowledge of physical chemistry and thermodynamics for research on process metallurgy, particularly slag-metal reactions. Experience in this field is desirable, but not essential. Starting salary according to qualifications. Apply: Assistant Director of Research, THE UNITED STEEL COMPANIES LIMITED, Swinden Laboratories, Moorgate, Rotherham, Yorks.

EXPERIMENTALISTS

required at

A.E.R.E., HARWELL

in an Engineering Laboratory, designing and operating test-rigs covering instrumentation; heat transfer and fluid mechanics; physical property measurements; handling of unusual fluids.

G.C.E. "A", H.N.C., or Degree Required.

SALARY: £990-£1,215, or £395 (at 18)-£855.

Housing; superannuation; excellent conditions.

Send POSTCARD for details to RECRUITMENT OFFICER (9662/215), A.E.R.E., HARWELL, DIDCOT, BERKS.

A FIRM in a traditional industry, a leader in that industry's modernisation, seeks GRADUATES in SCIENCE or ENGINEERING who can help to accelerate the application of scientific methods to conventional processes. Initial appointment will be to the Technical Department, which works in close collaboration with the Production Manager and his works staff. Appropriate candidates will be given a full training to enable them to take responsibility as project-leaders under the supervision of senior management. General prospects demonstrably good. Applications welcomed from graduates in their twenties, with critical minds and collaborative personalities. Strict confidence observed. Write Box No. C184, The New Scientist, Cromwell House, Fulwood Place, W.C.1.

ENGINEERS AND TECHNOLOGISTS

REGENT OIL CO. LTD.

to work in Technical Service Department dealing with customer service and product application. Preference will be given to applicants with B.Sc. or equivalent in Mechanical, Chemical or Marine Engineering. Experience in Petroleum Technology desirable but not essential.

Salary commensurate with age, qualifications and experience.

Pension Scheme, Luncheon Vouchers.

Apply to Personnel Officer, The Regent Oil Co. Ltd., 117, Park Street, London, W.1.

BRITISH NYLON SPINNERS LIMITED

has one or two vacancies

for

YOUNG MEN

seeking a career on the production side of an expanding organisation. The basic qualifications are a good standard of education, preferably up to University degree standard in science or engineering, powers of leadership and the ability to accept responsibility.

Some industrial experience is preferred, but a comprehensive training in modern production techniques will be given. Working conditions in a modern plant are excellent and rented houses are available in the area.

Applications from men aged 23—30 should be submitted in writing to the Personnel Manager, British Nylon Spinners Limited, Pontypool, Mon.

A LARGE and expanding West Country Company manufacturing a specialised product wishes to increase its TECHNICAL STAFF, with especial reference to production. Requirements are:—

A first or second class honours degree and a good grounding in general science; a real interest in production problems as distinct from pure scientific research; age up to 30; the capability to assume responsible positions in due course. Adequate salary will be offered to suitable men, according to age and past experience. Please write to Box No. C182, The New Scientist, Cromwell House, Fulwood Place, W.C.1, and quote Ref. No. M28.NS.

SEMI-CONDUCTOR DEVELOPMENT

THE RECTIFIER DIVISION, STANDARD TELEPHONES AND CABLES LTD. EDINGURGH WAY, HARLOW, ESSEX

has vacancies for

PHYSICIST/ELECTRICAL ENGINEER (Ref. C.2)

To work on the development of processes and techniques suitable for the manufacture of silicon power rectifiers.

CHEMIST (Ref. C.25)

For investigations of a Physico-chemical nature into improved methods of junction fabrication.

For these positions a degree or equivalent, and a minimum of 2 years' industrial experience is required, preferably in the fields of semi-conductors or component manufacture.

Salaries are fully commensurate with qualifications and experience, and are highly competitive.

A Non-contributory Pension Scheme is operated. HOUSING ACCOMMODATION is available in the New Town if required. Informal discussions can be arranged in London or Harlow. Please write quoting appropriate reference No. to the PERSONNEL MANAGER.

A.M.I.MECH.E., A.M.Brit.I.R.E., City and Guilds, etc., on "NO PASS—NO FEE" terms. OVER 95% successes. For details of Exams and courses in all branches of Engineering, Building, etc., write for 144-page Handbook—FREE B.I.E.T. (Dept. 963), 29, Wright's Lane, London, W.8.

CLASSIFIED ADVERTISEMENTS

The rate for classified advertisements is 7s. a line (or space equivalent of a line), with an extra charge of 1s. for the use of a box number. Late classified advertisements can be accepted at latest by first post Monday for inclusion in the same week's issue.

REPLIES TO BOX NUMBERS

should be addressed to the Box Number given, c/o **"The New Scientist," Cromwell House, Fulwood Place, High Holborn, London, W.C.1.**

Orders for classified advertisements are accepted on condition that the publishers may make any alteration to ensure conformity with the typographical standard of "The New Scientist."

FELLOWSHIPS, GRANTS AND SCHOLARSHIPS

7s. per line—Box Number 1s. extra.

LEVERHULME RESEARCH AWARDS

OVERSEAS SCHOLARSHIPS 1958

Application is invited for four scholarships offered to British-born graduates of United Kingdom universities who wish to undertake a period of advanced study or research at any of the University Colleges in Uganda, Nigeria, Ghana, Rhodesia or the West Indies. The value of the scholarships will be £750 for one year, renewable for a second year at £650. Candidates should be unmarried and under 25 years of age on 1st October 1958 (allowance will be made for National Service). They should be normally resident in the United Kingdom and available for interview in London in April.

Further information and details of the method of application are obtainable from The Secretary, Overseas Scholarships, Leverhulme Research Awards, St. Bridget's House, Bridewell Place, London, E.C.4. The closing date is 15 JANUARY 1958.

LONDON COUNTY COUNCIL

Robert Blair Fellowship in Applied Science and Technology

Applications are invited for the award of the Robert Blair Fellowship tenable for one year of advanced study or research abroad in applied science and technology. The value of the award is subject to variation, and if the country selected should be Canada or the U.S.A., may be up to £2,000 (subject to income tax).

Candidates must be British subjects and at least 21 years of age.

Further particulars and forms of application may be obtained from the EDUCATION OFFICER (E.O.WA.14), THE COUNTY HALL, S.E.1 (stamped addressed foolscap envelope necessary) for return by 28 February 1958. (2183).

LECTURES, MEETINGS AND COURSES

7s. per line

ORIGIN OF LIFE. Prof. J. D. Bernal, F.R.S., on recent Moscow conference and scientific discussions. Fri. Dec. 6, 7 p.m., at SCR. 14, KENSINGTON SQUARE, W.8. Adm. 1/6 (SCR members 1/)

BOOKS

7s. per line—Box Number 1s. extra.

SOVIET HIGH ALTITUDE ROCKETS, by A. A. Bagoutsavov. Also New work in Physics, Changed Views on Genetics, etc. Soviet Science Information Bulletin, Vol. 4, No. 3, 1/6 (post free 1/10) from SCR, 14, KENSINGTON SQUARE, LONDON, W.8.

MACHINERY AND PLANT

7s per line—Box Number 1s. extra

The Specialist Foundry

for

BLACKHEART MALLEABLE
IRON CASTINGS

HEAT AND ABRASION
RESISTING ALLOY CASTINGS

Manufacturers of

"PULMAC"
PULVERISING MILLS

FOLLSAIN-WYCLIFFE FOUNDRIES LIMITED,
Lutterworth, Nr. Rugby.
Tel.: 10, 60, 152.

MR AINSWORTH

Mr. Therm burns to serve you . . .

He uses coal, so important to Britain, with increasing efficiency :—

Production efficiency per cent. has been increased and more therms are obtained per ton of coal carbonised.

Thus he now uses *two million tons* less coal each year than if he was working at his 1948 efficiency figure.

Mr. Therm's oil gasification plants are producing useful gas from the products of the oil refineries. One plant at the Isle of Grain will, in this way, produce 80 million cubic feet of gas a day from oil.

Besides oil, waste refinery gas is used by Mr. Therm to supplement gas supplies.

Technical problems involving the transport, handling and storage of imported liquified natural gas are being studied — to this end a pilot scheme is expected to be in operation within the next eighteen months.

To meet the Clean Air Act, Mr. Therm's research programme includes the production of high grade smokeless fuels from coal.

The Gas Industry offers a wide variety of technical, administrative, commercial and clerical careers, and good opportunities for craftsmen.

For further particulars, write to the Industrial Relations Officer, Murdoch House, 1 Grosvenor Place, London, S.W.1.

MR. THERM'S INDUSTRY IS LIVE AND VITAL

Issued by the Gas Council